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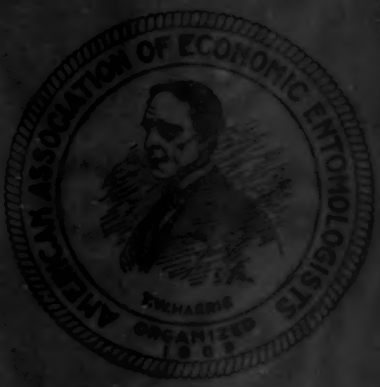

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VOL. 19 AUGUST, 1926 No. 4

Proceedings of the Annual Convention of the Cotton States Entomologists

Held at Biltmore Hotel, Atlanta, Georgia, February 3, 4, 5, 1926.

W. E. HINDS, *Chairman* G. M. BENTLEY, *Secretary*

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REPORT OF COMMITTEE ON SECURING RECOGNITION OF THE ASSOCIATION OF THE COTTON STATES ENTOMOLOGISTS AS A COTTON STATES BRANCH OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

In accordance with discussions and official action thereon by the Association of Cotton States Entomologists at their annual meetings in 1924 and 1925, your officers have continued their efforts to secure the recognition of the Association of Cotton States Entomologists as a Cotton States Branch of the American Association, in 1925 a formal application was made by the President, Vice-President, and Secretary of the Cotton States Entomologists to the President and Committee on Policy of the American Association of Economic Entomologists for such recognition. We submitted a list of more than 100 working entomologists located within the territory lying south and east of the northern and western limits of North Carolina, Tennessee, Arkansas, Oklahoma, and Texas which is considered as the territory covered by our organization, and programs of our annual meetings for several years past showng the general scope of topics considered and something of the extent of text matter that might be offered to the editors of the JOURNAL OF ECONOMIC ENTOMOLOGY for publication in case our application should be granted. This matter of demand upon publication space constituted one of the most serious conditions affecting our application.

As a tentative practicable solution of this difficulty, we suggested to the American Association the following specific points: (1) That acceptance of the branch organization would in our judgment increase the membership in the National Association, and thereby the income of the JOURNAL and its maximum publication capacity, (2) That in case it should be found necessary to limit the space allowed for publication of proceedings of branch organizations, such limitation might be accomplished by authorizing the Editors, or the Advisory Committee, of the JOURNAL of ECONOMIC ENTOMOLOGY to allot to such branch organizations the maximum total number of pages that might be allowed them for publication use. The branch organization might then provide for an Editorial or Publication Committee which might have in charge the arrangements for publication with authority to arrange with authors for publication through other mediums or for such abstracting or other reduction in volume as might be necessary to bring the publications offered to the JOURNAL within the limits allowed thereby.

Following this proposal our application received the unanimous approval of the Committee on Policy and of the Executive Committee of the American Association

of Economic Entomologists and was so reported during the first session of the American Association as held at Kansas City, Missouri on December 30, 1925. At that time and by unanimous vote of the active members present, the application was approved, and the Association of Cotton States Entomologists was officially received as the Cotton States Branch of the American Association of Economic Entomologists.

In accordance with the foregoing action, the President of the Cotton States Entomologists now becomes ex-officio fifth vice-president of the American Association of Economic Entomologists, and facilities for publication of our proceedings have been provided. Your President expressed in your behalf our appreciation of this favorable action and extended to the American Association again our sincere invitation that it be represented by an official delegate at our meeting in Atlanta, Georgia, February 3 to 5, 1926. In accordance with this invitation, President Arthur Gibson of the American Association designated Professor E. W. Cory, College Park, Maryland, as the official representative of the American Association.

Recommendations:

(1) Consequent upon the success of our application, your committee now recommends that it shall be made general, the policy in the Association of Cotton States Entomologists to hold a regular election of officers at each annual meeting with the expectation that there shall be a rotation in the offices of president and vice-president especially, such as prevails in the American Association of Economic Entomologists.

(2) We recommend also that a Committee on Publication be chosen or appointed at this meeting in order to carry out the purposes outlined in the above report.

(3) We recommend that a special effort be made by our Association to increase membership in the American Association and to stimulate throughout the Cotton Belt further interest in Economic Entomology as an honorable and useful profession.

Respectfully submitted,

Signed:

President, W. E. HINDS
Vice-President, R. W. HARNED
Secretary, G. M. BENTLEY

DISPERSAL HABITS OF THE COTTON BOLL WEEVIL *ANTHONOMUS GRANDIS* BOH.

By F. A. FENTON and E. W. DUNNAM, *Florence, S. C.*

(Withdrawn for publication elsewhere)

COTTON BOLL GROWTH IN RELATION TO BOLL WEEVIL INJURY

By E. W. DUNNAM, *Florence, S. C.*

ABSTRACT

This paper gives evidence that as the cotton bolls grow older they are less suceptible to boll weevil, *Anthonomus grandis*, injury, and the immunity at given ages varies with the variety. Dixie Triumph, Webber 49 and Humco Cleveland were the varieties studied, the first mentioned is the most susceptible and the last the most

resistant. There is no correlation between the number of feeding punctures or the number of egg punctures and the percentage of cotton loss. Neither is there any relation between the thickness of hull and susceptibility to weevil damage, in spite of the fact that the weevils lay fewer eggs in the thick-hulled varieties. The determining factor is the hardness of bolls because varieties with the hardest bolls, as determined by the number of grams pressure required to puncture them, show also the least per cent of cotton loss.

While studying the biology of the boll weevil at Florence, S. C., the question of boll susceptibility to weevil injury was often presented. During the summer of 1924, some preliminary work on this problem was conducted. While this work was of a preliminary nature, it was discovered that the different varieties of cotton offered a variable factor. In 1925, three of the most common varieties of cotton which are planted in the Pee Dee section were chosen for these tests, namely, Dixie Triumph, Webber 49 and Humco Cleveland.

These varieties, which were planted April 20, began to bloom July 8 and each variety was examined daily and the blooms tagged. The date was stamped on each tag so that the age of each boll could be ascertained at any subsequent date. Since it is definitely known by cotton physiologists that the developmental period from bloom to open cotton early in the season is considerably shorter than cotton developed late, the work, so far as possible, was conducted over the entire growing season.

A male and a fertilized female were placed in a muslin bag. This bag was placed over a non-infested boll and let remain for at least 24 hours and then moved to another boll for a new record. The boll from which the bag was taken was carefully examined and the damage recorded and the tag numbered. To prevent further injury by other weevils, a small paper bag was placed over the boll and securely tied. This operation was started July 25 and was continued until Sept. 3. On Sept. 9, at which date all of the bolls were open on the different varieties, the paper bags were removed and the final damage recorded.

The study of the growth of cotton bolls in connection with the susceptibility at different ages was thought to be very important. At a date when it was possible to secure bolls of all ages from one day, to the opening stage, a complete series of bolls was collected from each variety and prints made. This was done by cutting the bolls longitudinally with a sharp scalpel and carefully rubbing the entire surface with an indelible pencil and pressing it face down on drawing board.

These charts show that the one day bolls of the Dixie Triumph and Humco Cleveland averaged 8 by 14 mm. and grew at the rate of one and one-half mm. in width and two mm. in length per day up through

the 17-day period when they averaged 32 by 46 mm. The Dixie Triumph bolls were practically full grown at this age, while the Humco Cleveland grew at this same rate up through 22 days, averaging 39.5 mm. in width and 53.5 mm. in length, and after this time there was little change in the size of bolls. The Webber 49 bolls, one day old, averaged 5.5 by 12 mm. and grew at the rate of 1.6 mm. in width and the usual two mm. in length up through the 17-day period, averaging 31.5 by 44 mm. After this period, there was a much less growth up through 31 days, averaging 39 by 50 mm. or about one-half mm. in length and breadth per day.

It was easily seen by referring to these charts that on the thirteenth day traces of the inner membrane were sufficiently rigid to slightly print. In the dissection work, however, this membrane was recorded for all varieties at the end of the third day.

On Sept. 9, all of the bolls were examined to ascertain the boll weevil damage. From the results obtained, a graph was made showing the variation in susceptibility of the different varieties. For convenience in discussion, the bolls were grouped in five day periods. It was interesting to note that the damage varied somewhat on bolls from one to five days, inclusive, even though they were very young and tender. For bolls of this age, the cotton loss, as figured for the total number of locks, was 79.34 per cent for Dixie Triumph, 92.65 for Webber 49 and 100 per cent for Humco Cleveland. In the group for six to ten day bolls, the Dixie Triumph loss was 58.79 per cent, Webber 49, 57.42, and Humco Cleveland dropped from 100 to 67.64 per cent. For bolls 11 to 15 days old, the Dixie Triumph susceptibility is the lowest, with a loss of 32.25, Webber 49, 47.22 and Humco Cleveland 39.42 per cent loss. At sixteen to twenty days, Dixie Triumph averaged 18.04 per cent cotton loss which is less than Webber 49 at 23.22, but Humco Cleveland dropped to a loss of 11.00 per cent. Bolls 21 to 25 days old showed a loss of 17.79 with Dixie Triumph, 6.81 with Webber 49 and 3.57 with Humco Cleveland. In the 26 to 30 day group, Dixie Triumph showed a loss of 16.52 per cent, Webber 49, 7.69 and Humco Cleveland 2.37. Bolls 31 to 35 days old showed very little damage for either variety, which was as follows: Dixie Triumph 0.568 per cent, Webber 49, 1.56 and Humco Cleveland 0.92 per cent. Bolls 36 to 40 days old showed little change for Dixie Triumph, which was 0.531, Webber 49, 1.56 and Humco Cleveland 1.85. There was no loss with either variety for bolls 40 days or older.

It is seen that even though Humco Cleveland showed a 100 per cent loss for bolls from one to five days that after the 15-day period, it showed

considerable less damage than either of the other varieties down to the point where the damage was almost negligible.

The damage, no doubt, was concentrated in all of these tests by forcing a pair of weevils to remain on the bolls at least 24 hours. It is almost impossible, however, to determine just what happens under field conditions, but this work shows the possibilities in case seasonal conditions force the cotton plants to drop the squares, thereby leaving nothing but bolls in which the weevils can feed and oviposit.

Our records show that the minimum number of feeding punctures per boll for Dixie Triumph was 0 and the maximum 20, but the average for all records was 5.3. The feeding punctures for Webber 49 fluctuated from 0 to 50, the average being 5.8 per boll. For Humco Cleveland, the minimum was 0 and the maximum 30, but the average of 4.73 is less than that for either of the other two varieties. The average feeding punctures for five day periods for the latter variety remains below the other two, until we reach the 35 day age, then it slightly exceeds the other two, then drops between them with an average of 3.6. At 45 days, it is practically as resistant to feeding punctures as either of the others. The greatest number of feeding punctures per boll was recorded at 15 days for the three varieties.

The egg punctures for Dixie Triumph ranged from 0 to 10, with an average of 1.18. For Webber 49, the egg punctures ranged from 0 to six, with an average of 0.73 per boll. Humco Cleveland bolls showed a range in egg punctures from 0 to 10, with an average of 1.04. It is seen that Dixie Triumph is the most susceptible to egg punctures up until the 20th day when it falls below Humco Cleveland for a five day period, then it rises to 0.87 as compared with 0.56 for Webber 49, and 0.58 for Humco Cleveland. Again, it falls between these varieties at 35 days with an average of 0.17. Humco Cleveland lies between the other varieties with two exceptions at 20 and 35 days, respectively. Webber 49 had fewer egg punctures than either of the other two varieties. The average peak of egg deposition for all varieties was reached at 15 days, as in the case of feeding punctures.

By a close examination of the data it is evident that there is no correlation between the number of feeding punctures nor the number of egg punctures and the percentage of cotton loss. Neither is there any correlation between the thickness of hull and percentage cotton loss.[1] This is due to the fact that bolls of certain thick-hulled varieties are harder early in the season than they are if developed later on. For ex-

[1]G. M. Armstrong, unpublished data.

ample, a 34-day old boll of Webber 49 developed in July and August is harder than a 34-day boll of the same variety when developed in August and September. Of the three varieties under test, the hulls of the Dixie Triumph bolls at 27, 34 and 41 days were the thinnest, Humco Cleveland next for bolls of the same ages and Webber 49 the thickest of all. If we compare these thicknesses with the average number of eggs deposited, it will be seen that there is a correlation between these two factors. For instance, Dixie Triumph—shown to have, as a rule, the greatest number of eggs is also the thinnest hulled variety of the three. On the other hand, Webber 49 has the smallest average number of egg punctures and the thickest hull. But the number of eggs deposited in older bolls is not the only determining factor in boll resistance to final weevil damage when this is determined by percentage of cotton loss. Humco Cleveland shows the least cotton loss because it reaches the age when it is fairly immune to weevil attack the earliest. Webber 49 is next and Dixie Triumph is least in this respect. If we compare the cotton loss for the three varieties at 27 days, it will be seen that the Dixie Triumph shows the greatest loss, Webber 49 next and Humco Cleveland least. This corresponds with Armstrong's data showing that the total number of grams pressure required to puncture the outer hull and inner membrane is less for Dixie Triumph than for Webber 49, and less for Webber 49 than for Humco Cleveland. The determining factor, therefore, is the hardness of bolls. It is seen that the latter variety possesses a very important characteristic for a cotton to be grown under boll weevil conditions.

THE BREEDING OF BOLL WEEVILS FROM INFESTED COTTON SQUARES[1]

By Bernard Gehauf

Abstract

From a total of over 95,000 infested squares, about 37,000 boll weevils, *Anthonomus grandis*, were obtained, which represents an emergence of 39.2 per cent. These weevils were used in the toxicity work of the Chemical Warfare Service along with 60,000 additional field weevils.

The best results were obtained by infesting field cotton at the rate of one weevil to five squares, and picking the infested squares a week or ten days after they had been punctured. If the percentage weevils to squares ran higher than one weevil to five squares, the weevils were hand picked down to this ratio. This prevents feeding and egg punctures on the same squares.

The infested squares were then placed in an incubator, one layer thick, on shallow

[1]Published by permission of the Chief of the Chemical Warfare Service, U. S. A.

trays containing about an inch of moist sand. They were kept from becoming too brittle by spraying lightly with water as necessary. It normally required about two weeks in the incubator for completion of each batch. Weevils were supplied at the rate of more than 2,000 per week until sufficient field weevils were available for the work.

Acknowledgment

The cooperation of the Florida Experiment Station personnel is gratefully acknowledged. In addition to Dr. Wilmon Newell especial thanks are due Dr. A. F. Camp, and P. W. Calhoun, of the Experiment Station Staff. Free use was made of the facilities of the Station, and the technical advice of those consulted was invaluable. Acknowledgment is also made to H.W. Walker, in charge of the Boll Weevil Investigation for the Chemical Warfare Service, for his advice in this work.

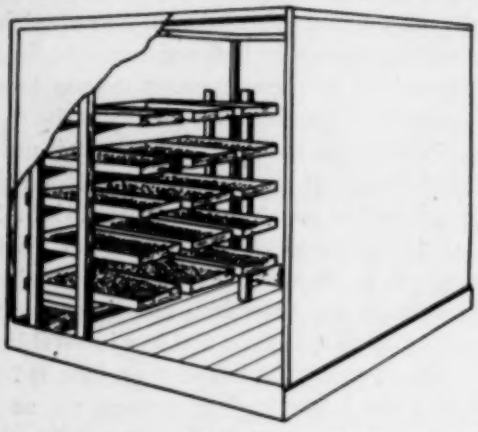

Fig. 35.—Boll-weevil incubator. Cloth on wood frame. No provision for heating.

I. Introduction

The purpose of this work was to obtain an early supply of weevils, *Anthonomus grandis* Boh., for toxicity tests. Work was started at Gainesville, Florida, on April 1st, 1925. Some cotton roots in a field near the campus had remained alive from the previous winter, which had been mild in this vicinity, and in April began to put out sprouts and a few squares. Two other fields in which the plants themselves had remained green throughout the winter were located farther south, one near Groveland, Florida, and the other near Sanford. These fields supplied the squares and weevils needed for the work until June 1st when newly planted cotton reached the square-bearing stage. In addition, about 200 hibernated weevils were obtained from Madison, Florida, and two thousand squares from a species of sea-island cotton growing in an uncultivated state in the vicinity of Homestead, Florida. With the exception of these squares, all squares, bolls, leaves, etc., used in the work were obtained from varieties of upland cotton.

II. Historical

The breeding of weevils in the laboratory from punctured squares is not new although in most of the previous work the primary object was the study of the biology of the weevil and not the production of weevils on a large scale. The earliest work of this nature was done at Victoria, Texas, in 1902 and 1903.[2]

They obtained 39.4% emergence from punctured squares. G. D. Smith[3] at Madison, Florida, reported a 36.9% hatch from 4000 carefully selected punctured squares from upland cotton and a 49.4% hatch from an equal number of squares from sea-island cotton.

III. Experimental Details

A. Apparatus: Two incubators for punctured squares were constructed. One, approximately 5 ft. long by 3 ft. wide by 7 ft. high, consisted of a wooden frame panelled with "Celloglass" and fitted with a door that could be tightly closed. This incubator contained a rack capable of holding twenty wooden trays, each 24 inches long by 12 inches wide by 2 inches deep. During cool weather an oil heater was installed for keeping up the temperature at night. The second incubator was built of light muslin cloth over a wooden frame. It was 6 feet square and 6 feet high, contained a rack for forty trays, and had no provision for artificial heating. Both incubators were set up in one of the State Board barns.

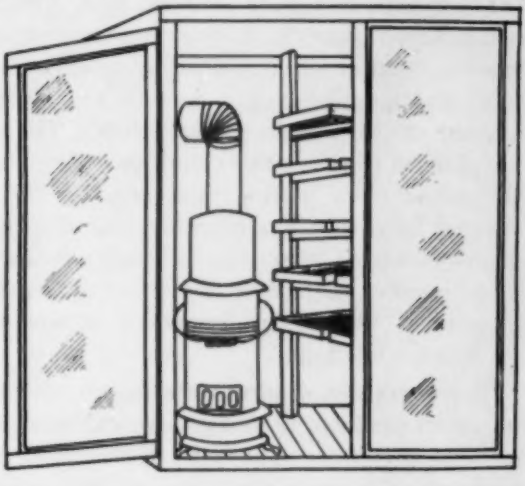

Fig. 36.—Boll-weevil incubator. With provisions for heating.

B. Method: During the early part of the work the available supply of squares and weevils for breeding purposes was very limited. Some

[2]Hunter and Hinds.—The Mexican Cotton Boll Weevil. U. S. Dept. of Agriculture Bulletin No. 51.

[3]G. D. Smith—Studies in the Biology of the Cotton Boll Weevil on Short Staple Upland, Long Staple Upland, and Sea-island Cottons. U. S. Dept. of Agriculture Bulletin No. 926, April 19, 1921.

unpunctured squares were obtained from uncultivated sea-island cotton growing in the vicinity of Homestead, Florida, and several hundred hibernated weevils were received from Madison. Using these squares and weevils an attempt was made to carry out the breeding in tumblers. This proved unsatisfactory, the weevils refusing almost entirely to accept the squares for the deposition of their eggs, and of the small number of eggs deposited, only a few developed.

The most satisfactory method of breeding was found to be that of infesting the growing cotton with weevils and picking the egg-punctured squares a week or two after the punctures were made. This stage was indicated by the yellowing of the squares and by the ease with which they could be removed from the plant.

Infestation of the campus field was started by releasing 250 hibernated weevils uniformly over the field, which contained approximately one hundred plants in the early square-bearing stage. This infestation was too great as was indicated by an excessive number of feeding punctures and hand picking of weevils was resorted to until there was an average of two weevils to each plant. The average number of squares per plant at this time was about ten. Egg-punctures may be readily distinguished from feeding punctures by the fact that the former are covered by a wart-like excretion and the latter are left open. A high degree of weevil infestation is roughly indicated by the appearance of a large number of feeding punctures in squares that also contain egg punctures. Where the proportion of squares per weevil is large this condition is not found.

The punctured squares were spread one layer deep on trays containing moist sand and placed in the incubator. During development of the embryo weevil the squares were kept from becoming brittle by lightly spraying with water when they showed evidence of becoming too dry. During cool weather the temperature was kept up to 80°–90°F. using an oil heater for the purpose. When the weather was warm, no artificial heat was used. The progress of the development of the weevil was noted by opening a few squares at intervals of a few days.

Approximately ten days were required after the square was picked for the weevil to develop and emerge.

The newly hatched weevils were fed for several days before shipment. This was accomplished by confining them in large battery jars containing a supply of squares and tender tips of the cotton plant. Food was changed about every two days.

Containers for shipping weevils were made of half-pint paste-board ice cream cartons. These were ventilated by fitting wire screen in holes cut in each end. A maximum of two hundred and fifty weevils was packed in each container, together with cotton leaves and small squares (no bolls or other hard material that could cause mechanical injury to the weevils), the lid was sealed with adhesive tape and the whole wrapped tightly with cheese-cloth. The object of the latter was to prevent escape of weevils in case the carton was crushed during shipment. Two of these cartons were packed end to end in a corrugated board box provided with holes for ventilation.

IV. Hatching Data

The following table shows the dates of gathering squares between April 3rd and June 19th, the time required for the development of the weevil, and the total emergence and percentage of hatch.

Table 1.—Hatching Data.

Date gathered 1925	Source	Number of squares	Time required for development	Total emergence	Percent hatched
			Days		
April 3	Groveland	1000	14–17	200	20.0 (1)*
April 10	Groveland	2000	12–15	465	23.2 (1)*
May 11	Gainesville Campus	125	13–15	88	70.4 (2)
May 12	Gainesville Campus	550	12–15	110	20.0 (3)
May 18	Gainesville Campus	870	9–14	410	47.1
May 22	Gainesville Campus	850	9–13	268	31.4
May 25	Gainesville Campus	614	7–14	182	29.6
May 26	Gainesville Campus	345	11–16	73	21.1
May 28	High Springs	220	9–14	66	30.0
May 29	Gainesville Campus	555	10–14	127	23.0
May 30	High Springs	250	10–16	100	40.0
June 3	Gainesville Campus	460	12–16	95	20.6 (4)
June 4	Gainesville Campus	500	11–13	114	22.8 (4)
June 5	Gainesville Campus	900	11–14	305	33.9
June 8	Gainesville Campus	1200	10–15	492	41.0
June 9	Gainesville Campus	700	10–14	367	52.4
June 9	Plant Board Field	550	10–13	137	25.0
June 10**	Plant Board Field	4000 approx.	9–13	986	24.6 approx.
June 11	Gainesville Campus	850	8–12	291	34.2
June 12	Plant Board Field	320	10–11	150	46.9
June 14	Sanford	2000	9–13	660	33.0
June 16	Gainesville Campus	1000	10–12	300	30.0
June 17	Gainesville Campus	1900	11–14	445	23.4
June 19	Plant Board Field	750	10–12	325	43.3
April 3 to June 19		22,500	7–17	6,656	29.6

Approximate temperature, midday = 85–95°F.
Approximate Relative Humidity, midday = 65–80%.

(1) Low percentage hatch from these squares probably due to fact that they were kept closely packed for a considerable time during transportation to the incubator, during which time the heat of fermentation had become very high.

(2) These squares were carefully selected both for size and absence of feeding punctures. Many of them also contained two or more egg-punctures.

(3) Low yield due to large number of feeding punctures.

(4) This lot contained many squares that had fresh egg-punctures. Practically all of these failed to develop.

*All weevils from this hatch died on the fifth day after emergence. The exact cause could not be determined but was probably due to over crowding and to excessive moisture in the jar.

**Squares received from Dr. Camp from stripping of plot devoted to experimental work on the Florida Method of controlling weevil infestation.

By June 19th the number of punctured squares had increased to such an extent that it was not practical to keep each day's lot separate. From June 19th to August 20th the weevils were incubated in the cloth incubator and on emergence were allowed to fly to the sides from whence they were gathered.

Number of squares gathered June 19 to August 20	72,550
Total number emerged	30,670
Percentage emerged	42.2%

The total over the whole season from April 4th to August 20th, was as follows:

Total number of squares gathered	95,050
Total number of weevils emerged	37,326
Total percentage of emergence	39.2%

After August 20th sufficient field weevils were obtainable so that this work was unnecessary to insure a sufficient supply and was therefore discontinued.

V. Conclusions

1. For the production of large quantities of weevils it is best to carry out the breeding and egg laying in the field under natural conditions, and the hatching in incubators.

2. The degree of infestation of the field should be controlled so that egg-punctured squares are not ruined by feeding punctures. This may be accomplished by picking the weevils by hand from the plants where they have become too numerous.

3. The squares should be allowed to remain on the plant one to two weeks after eggs have been deposited. During this period the square will continue its growth and store up additional food for the embryo

weevil. The end of this period is shown by the yellowing of the square and the ease with which it can be removed from the plant.

4. Squares that are freshly picked should not be allowed to remain tightly packed for more than an hour or two. In such condition fermentation sets in attended by a considerable rise in temperature which might be sufficient to kill the embryo weevil.

5. Squares should be spread one layer deep on trays partly filled with a layer of moist sand. An ideal temperature for incubation seems to be 80° to 90°F. but most of this season's work was done at ordinary atmospheric temperatures. During development the squares are kept just sufficiently moist to prevent brittleness. Too much moisture will cause the squares to mould and rot before the weevil has reached its full growth.

6. Feeding newly hatched weevils is accomplished by confining 300–400 weevils in a battery jar with tender sprigs of cotton containing squares and blossoms. The weevils are inclined to gather to the side and top of the jar nearest the light but this may be overcome to a large extent by having the jar almost completely but loosely filled with twigs and leaves.

BOLL WEEVIL CONTROL RESULTS FOR 1925
ANTHONOMUS GRANDIS BOH.

Dr. W. E. HINDS, *Baton Rouge, La.*

In response to questionnaires sent to more than 30 of the Cotton States Entomologists, answers were obtained from all of the States producing the crop. From these reports the climatic conditions were found to be remarkably uniform during 1925 all over the South. Between the months of April and August, the rainfall was much lower than usual, and there was more than the normal amount in the fall. Temperatures were uniformly higher in April over the entire belt, than normal, lower in May, and the summer months were excessively hot everywhere. The months of October and November were cooler than usual.

The excessive heat and drought exerted a remarkable effect on the abundance of the weevils during the season. At the start of the season weevils were fairly abundant, but during the time when they usually are most harmful, they were almost eliminated by weather conditions. During the fall, there was an increase in numbers in some sections, and the indications are that enough weevils are hibernating to do damage in 1926, under normal weather conditions.

The fruiting of the cotton during the 1925 season was heavy, and in most cases crops were produced without any dusting whatever. Except in three tests, dusting experiments were generally without significant results, because of the minimum number of weevils working in the fields during the summer. In one Louisiana test, the regular dusting treatments gave an increase of 523 lbs. of seed cotton per acre, on eight acres, in comparison with undusted cotton. In Mississippi and North Carolina also, dusting gave increased yields, in plat tests.

It was generally conceded that cotton lice were more abundant on dusted fields, than on undusted. The reasons for this were not apparent. The cotton leaf-worm stripped the plants in Mississippi, Arkansas, Louisiana and Texas, but this was followed by renewed growth in the southern portions, before the plants were killed by frost.

It is probable that many cotton growers have come to the conclusion that the boll weevil menace is lessening, but it is believed that with normal weather conditions, they will damage cotton just as severely as in the past, unless dusting continues as a farm practice.

COOPERATIVE OBSERVATIONS ON BOLL WEEVIL HIBERNATION

By B. R. Coad, *Tallulah, Louisiana*

(Paper withdrawn for publication elsewhere)

PROGRESS REPORT OF WORK OF THE CHEMICAL WARFARE SERVICE ON THE BOLL WEEVIL *ANTHONOMUS GRANDIS*

By H. W. Walker and J. E. Mills

Abstract

1. Preliminary tests have been made on some 1,000 poisons or poisonous mixtures, and of these about 50 have shown a toxicity equal to or greater than calcium arsenate. About 20 of these materials show little or no injury to the cotton plant. A total of over 100,000 weevils were used in the tests made.

2. Barium, lead, zinc, mercury, and to a less extent iron, have shown up in the tests as having some measure of toxicity to the boll weevil when combined with other chemical groups in themselves harmless, and the toxicity of these metals seems, in general, to be retained when combined with arsenic, and to increase the toxicity of the resulting arsenical.

3. Sodium fluosilicate, barium fluoride, and cryolite seem to be equally as effective as calcium arsenate on a volume for volume basis. Every effort should be made to decrease the specific gravities of these compounds so as to give them the same covering power as the calcium arsenate.

4. It is believed that an advantage will be gained if the percentage of arsenic in calcium arsenate is reduced and a larger amount per acre used.

5. Arsenic trioxide or arsenic pentoxide, in relatively small percentages, absorbed on coal dust or some similar vehicle may make an effective economical poison against the boll weevil if some agent such as an oil be used to prevent plant burning.

6. The weevil seems to get most of the poison by more or less accidentally coming in contact with the dust particles and subsequently taking the same into its system. The weevil does obtain some poison through its food and drink.

7. High concentrations of toxic gases are ineffective against the weevil due to its apparent ability to suspend breathing more or less at will. There may still be a possibility that low concentrations of a persistent cumulative gas on adsorbents may give effective control.

8. The amount of arsenic in the best available form (soluble As_2O_3) necessary to poison a weevil is estimated as about 0.00015 mg.

9. The average weight of a boll weevil is 16 mg. The average quantity of water drunk per day is roughly estimated as 0.0025 cc. (2.5 mg.), and the air breathed per weevil per hour is very roughly estimated as 0.46 cc.

10. The work has emphasized the necessity for the very careful management of dusting machinery so as to secure an even distribution of the poison over the plant. A calm, or a very low, wind is a necessity. The cotton plant should be moist, if calcium arsenate is used.

RECOMMENDATIONS REGARDING BOLL WEEVIL WORK

By J. E. Mills, *Washington, D. C.*

Abstract

1. It is recommended that the method of control of the boll weevil (*Anthonomus grandis*) as described by the Southern Agricultural Workers Association, using calcium arsenate as a dust, or in special cases as a syrup mixture, be strictly adhered to for the time being.

2. Sodium fluosilicate, and possibly cryolite and barium fluoride, volume for volume, are equal or very nearly equal to calcium arsenate as a posion for boll weevil control. These substances should be subjected to further careful and extensive field tests to determine their exact value, using 10 to 15 pounds per acre. Every effort should be made to decrease the density of these poisons, and as the density of the poisons is lessened, the amount used per acre can be decreased.

3. It is believed that an advantage will be gained if the percentage of arsenic in calcium arsenate is reduced and a larger amount per acre used. Careful field tests should be made to establish definitely the value of this suggestion.

4. It seems quite possible that arsenic trioxide absorbed on coal dust or similar vehicle will make an effective and cheap poison for use against the boll weevil if some agent, such as an oil, is used to prevent plant burning. One and one-half per cent arsenic trioxide on coal dust only shows occasional burning. It is recommended that field tests using this amount of arsenic trioxide on coal dust at the rate of 10 to 15 pounds per acre be tried.

Other powerful poisons should be investigated as to their possible use in this way. Probably a similar trial with arsenic pentoxide is worth while.

5. High concentrations of toxic gases are ineffective against the weevil due to the apparent ability of the weevil to suspend breathing more or less at will. There is still a possibility that low concentrations of a persistent cumulative gas may give an effective control. Some further research work along this line has yet to be undertaken.

EARLY SUMMER DISPERSION OF THE BOLL WEEVIL

By DWIGHT ISELY, *Fayetteville, Arkansas*

(Paper withheld for publication elsewhere)

STATUS OF INVESTIGATIONS OF ATTRACTANTS FOR THE BOLL WEEVIL

By J. W. FOLSOM, *Tallulah, Louisiana*

(Paper withheld for publication elsewhere)

REMARKS ON THE LIFE HISTORY OF THE MEXICAN BEAN BEETLE

By L. W. BRANNON, *Birmingham, Alabama*

(Paper withheld for publication elsewhere)

PRELIMINARY REPORT ON SODIUM FLUORIDE AS A CONTROL FOR CATTLE LICE

By F. E. GUYTON, *Auburn, Alabama*

This experiment was started in February 1925 with an idea of getting a better method of controlling cattle lice. The materials used were sodium fluoride and nicotine dust F. 2. The first applications were made February 5 to 10 head of fattening cattle owned by the college. They were in excellent condition, except for the lice. The infestation was high. Many places were found where the lice showed a gregarious instinct and clustered in groups of thirty to sixty on an area about the size of a dollar. These groups were found more often on the shoulders and neck than on the rump. Of the five treated with sodium fluoride one only showed infestation the next day after treatment and all lice were dead the eighth day after treatment. Of the five treated with nicotine dust all showed infestation 8 days after treatment.

Since no bad effect appeared from the first treatment of sodium fluoride and due to the fact that it seemed to give perfect control it was decided to treat the entire college herd with this material. The herd consisted of 86 head cattle of the following breeds: Jersies, Holstein,

Hereford, Durham, Guernseys and Angus. Even calves 3 or 4 days old were treated.

Applications were made from 8–10 a. m. February 22. February 23 a few living lice were found on those that were most heavily infested. March the first living lice were found on two old Holstein cows, both having an extremely thick covering of hair. March 9th one of the Holsteins died, and the other had no living lice. Inspection was again made April 25, at which time no living lice were found.

Method of Application

The sodium fluoride was applied to the neck, shoulders, and rump by means of a small tin shaker, after which it was rubbed into the hair by the naked hand.

Types of Lice Present

Three species of lice were present which the writer identified as biting louse of cattle, *Trichodectes scalaris*, the short nosed ox louse, *Haematopinus eurysternus* and the long nosed ox louse, *H. vituli*. For the first time in five years the chewing type was more numerous than the sucking.

Treatment required practically one ounce of the dust per head, herd run, making the cost of material less than 2 cents per head. One man can treat 40 head per hour.

THE NEW DAY IN ENTOMOLOGY

By Ernest N. Cory, *State Entomologist, College Park, Md.*

Abstract

Briefly recounts the beginnings of Economic Entomology and its expansion to its present high state of efficiency. The tendency towards cooperation in the research, educational, extension and regulatory fields is beginning to be apparent. Cooperation offers the best avenue for increasing the efficiency of entomological work.

In a science that is moving as rapidly as entomology, it is well to look back periodically to see from whence we have come; to note the steps in that progress and with this background in mind look towards the future. Let us, therefore, first, look to the beginnings of economic entomology in this country.

In 1841, Dr. T. W. Harris published his first report on "Insects Injurious to Vegetation." This was in conformity with a resolution of the legislature of Massachusetts authorizing the work and directing its publication. In 1856 Dr. Asa Fitch presented to the legislature of the State of New York his first report on "The Noxious, Beneficial and

Other Insects of the State of New York." These two reports mark the beginning of official entomological work in the states, and as far as I have been able to ascertain, both men worked alone, accomplishing in a short period a relatively enormous amount of work. Following these two pioneers, work was started in Illinois in 1867 with the appointment of Benjamin G. Walsh, who was succeeded by William Le Baron, and he, in turn, by Cyrus Thomas. In 1869, C. V. Riley began his labors which culminated in the nine Missouri Reports. The Federal work was begun in 1854 with the appointment of Townend Glover. All of these men worked alone in an almost virgin field with little intercourse with their fellow workers in other states.

With the organization of the Experiment Stations in 1888, an official status was given to work in entomology, not theretofore, universal. Dr. Lintner, in his first report says, "there is no doubt but that it would be wise economy for every state in the union to have a properly qualified officer charged with the study of insect injuries and benefits, and that several times his salary would thereby be saved to the state." Surely we can all agree that this is a very conservative statement of the value of the economic entomologists. Soon, the various states established work in entomology. Now it is a recognized part of each state organization. From isolation we have progressed by gradual steps to a point of mutual helpfulness, exemplified to a very high degree in meetings such as the annual meeting of the Association of Economic Entomologists and sectional meetings such as this.

Closer affiliation of entomologists to rout the common enemy was the next step brought about in a large measure by the more important outbreaks of imported insect pests.

Outbreaks, such as the gypsy moth in the early days, and later the boll weevil, the Japanese beetle, the European corn borer and a number of other insects, have brought about regional problems, familiar to you all. Since insects do not recognize state or national lines, of necessity cooperation has become the moving force today, both nationally and internationally.

Cooperation in Entomology is found in all of the major fields, even in the teaching of entomology through the exchange of professors and lecturers. The more important cooperation of today lies in the regulatory field, though some cooperation in research and extension work has made its appearance.

In passing, it is well to remember some of the phases of research in which cooperative work has been accomplished. Much has been done

by the Federal Department in cooperation with the states, yet much remains to be done. Cooperation between the states in investigational problems has been difficult, but some work along this line has been effected, and with the stimulus of the Purnell Act, it is hoped that a greater measure of success will attend the efforts to work together on the larger problems. As an example, the conference of the four states, Pennsylvania, West Virginia, Virginia and Maryland, on the apple problems of the Cumberland-Shenandoah section at Winchester last July marks a step forward. As this territory is quite similar throughout the four states, the problems are nearly identical. At this meeting, attended by the directors and workers in Entomology, Pathology and Horticulture, three research problems were selected as of major interest and definite projects were worked out to be pursued jointly by the states at interest. One of the projects is in entomology.

More recently a conference to discuss the progress that has been made on the biology of the oriental fruit moth was called by the State of Pennsylvania, at which there were in attendance representatives of the Bureau of Entomology and of the states of Connecticut, New Jersey, Pennsylvania and Maryland. The results of the several investigators were presented in detail and discussed thoroughly. Other such conferences are taking place in every region, representing the present spirit of the times in economic entomology.

In the extension field, the consolidated spray program that will be issued this year for the Cumberland-Shenandoah section of Pennsylvania, West Virginia, Virginia and Maryland, and the joint extension program directed towards the control of the potato tuber moth might be offered as evidence of the trend of the times. These latter recommendations were drawn up in a conference of the representatives of Maryland, Virginia and the Bureau of Entomology in late September. Out of the conference of the Cotton States Entomologists has come the unified program directed against the boll weevil as one of the most significant accomplishments of entomological cooperation.

By far the greatest development, however, has been in the regulatory field. This was probably a natural development as, "in union there is strength," especially in fighting insects. The establishment of the Federal Horticultural Board was the beginning. The cooperation which it gives to the states and which, in turn it receives from the states establishes its greatest utility and strength.

More recently the western states established the Western Plant Quarantine Board, which has served the interest of that territory ad-

mirably, in coordinating the regulatory work of that section. It has, moreover, served as the model for the establishment of the Central States Advisory Plant Board, including the Mississippi Valley States north of the cotton territory and last year the establishment of the Middle Atlantic and Northeastern States Plant Conference Board. With the establishment of a similar board in the Southern states, it is hoped that all may be consolidated into a union having a National Board of Review, whose function will be the coordination of the regional regulatory work and its correlation with the work of the Federal Horticultural Board. It might not be amiss to state at this point the object of the Middle Atlantic and Northeastern States Plant Conference Board, which is as follows: "The business of this organization shall be the promotion of the efficiency of plant pest control, with due regard to the agricultural, industrial and urban business interests of the territory covered by its operation."

Many matters may properly come before such a body. As an example of unified action the Central States Plant Conference Board has decided upon uniform action designed to keep the alfalfa weevil out of the Mississippi Valley. Especially in the field of quarantines, it is hoped that the principle evolved at the Washington conference of the Federal Horticultural Board in 1924 will govern all states and regional boards. This is as follows: "A state considering the issuance of a quarantine or other regulation of interest to another state, shall send notice as far in advance as practicable to the Federal Horticultural Board, to quarantine officers of other states and to others in interest."

From isolation we have passed by halting steps to the stage of mutual helpfulness, and it is believed that we can look forward to a future which will see (1) a thoroughgoing and continuous cooperation between states, and between the Federal Government and the states in research, (2) coordination of extension programs in the regions where identical crops, physical conditions or pest incidence prevail, and (3) a more complete adjustment of all regulatory matters through regional conferences so as to secure the greatest amount of protection with the least disturbance of trade.

ENTOMOLOGY A NECESSITY IN AGRICULTURAL COURSES

By T. H. McHatton, *Athens, Georgia*

(Paper withheld for publication elsewhere)

Thursday, February 4, at 2:00 p. m.

THE POTATO TUBER MOTH IN THE EAST

By HERBERT SPENCER, *Baton Rouge, Louisiana*

(Paper withheld for publication elsewhere)

WHY NOT ERADICATE THE ARGENTINE ANT?

By R. W. HARNED, *A. and M. College, Mississippi*

(Paper withheld for publication elsewhere)

AIRPLANE DUSTING OF COTTON FOR BOLL WEEVIL CONTROL

By W. E. HINDS, *Entomologist, Louisiana Experiment Station*

ABSTRACT

The widespread use of airplanes for the dusting of cotton for boll weevil control constitutes the most striking advance step in weevil control work for 1925. Experimental work in this field has been conducted through cooperation between the Army Air Service and the Delta Laboratory at Tallulah, Louisiana under the direction of Mr. B. R. Coad since 1922.

A regularly organized commercial airplane dusting service was first available for the season of 1925. An airplane especially constructed for dusting work carries 500 pounds of calcium arsenate at a load. The plane is flown back and forth across the cotton fields at a height of from 10 to 25 feet and so that the dust cloud will cover a strip of cotton from 200 to 250 feet wide. These planes travel at a speed of 100 miles per hour, dusting an acre of cotton in less than two seconds. One plane can protect 5,000 acres of cotton through the season. Such service is available to cooperating groups of planters situated in territory favorable for airplane work and within a radius of from 10 to 15 miles usually from a central landing field, at a cost practically the same as for doing their own work. This puts boll weevil control work into professional hands and relieves planters and plantation labor from disagreeable night work. Airplanes are able to dust in daylight in spite of light breezes and can give very prompt protection after heavy rains and to the rankest growth of cotton. In practical use they have proven to be very satisfactory in controlling the boll weevil on cotton and have been used successfully also for treatment for peach orchards for the control of plum curculio and brown rot.

THE "CLOUD DRIFT" VERSUS THE REGULAR METHOD OF DUSTING

By W. E. HINDS, *Entomologist, Louisiana Experiment Station*

ABSTRACT

"Cloud-drift" is a term used to describe a comparatively new method of distributing poison for boll weevil control. By this method part at least of the dust cloud is thrown relatively high in the air above the cotton plants, and this cloud then drifts slowly across the field giving a fairly even distribution of poison over a number of

rows beyond those covered directly by the dusting machine. The rate of dust discharge is increased so that the actual amount of poison applied per acre is practically the same as by the usual methods of application.

At the Louisiana Experiment Station in 1925 a test was made of the "cloud-drift" method in comparison with regular methods of dusting. The regular dusted areas included two plats treated with hand gun, two plats dusted with a Root 2-row traction duster, and one plat dusted with a Niagara 3-row duster. The average yield of these five regularly dusted plats was 1282 pounds of seed cotton per acre. The average yield on three check areas associated with these plats was 781 pounds. The apparent gain from regular dusting was, therefore, 501 pounds of seed cotton per acre or a gain amounting to 64% of the average check yield.

In comparison with the foregoing the cloud-drift dusted plat, located in the middle of this entire series, with an area of approximately one acre and with undusted check areas on each side, gave a yield of 1380 pounds of seed cotton per acre. This shows an apparent gain of 599 pounds of seed cotton per acre or a gain amounting to 77% of the average check yield. This difference amounting to 98 lbs. of seed cotton per acre in favor of the cloud-drift area is more than could reasonably be attributed to any differences in stand or fruiting capacity. It appears that the cloud-drift method will be limited in usefulness by the narrow range of atmospheric conditions within which it can be applied, but that when these conditions do occur and the direction of the drift is across the rows, advantage may be taken of the cloud-drift method to save at least one-half the time required for making the application by the usual every row treatment.

CONTROLLING THE MEXICAN BEAN BEETLE

By NEAL F. HOWARD, *Birmingham, Alabama*

(Paper withheld for publication elsewhere)

MEXICAN BEAN BEETLE IN SOUTH CAROLINA FOR 1925

By C. O. EDDY, *Clemson College, South Carolina*

(Paper withheld for publication elsewhere)

AIRPLANE DUSTING OF PEACH ORCHARDS

By OLIVER SNAPP, *Fort Valley, Georgia*

(Paper withheld for publication elsewhere)

REPORT OF COMMITTEES

The Committee on Nominations recommended the following officers: President, Franklin Sherman, Clemson College, South Carolina; Vice-President, B. R. Coad, Tallulah, Louisiana; Secretary, G. M. Bentley, Knoxville, Tennessee.

For Publications, the Committee recommended the following:—G. M. Bentley, Knoxville, Tennessee; R. W. Leiby, Raleigh, North Carolina; Dwight Isely, Fayetteville, Arkansas.

The Report of Nominations Committee was received and passed unanimously.

COMMITTEE ON RESOLUTIONS

Your committee on Resolutions begs leave to report as follows:

Resolved, That the Cotton states entomologists appreciate the recognition given them by the American Association of Economic Entomologists as a regional branch.

That we urge southern entomologists to become regular members of the A. A. E. E., especially in view of the fact that the latter association and the Journal which it publishes, will contribute materially to the moral and financial support of the Cotton States Branch in the sending out of notices of meetings and particularly in the publishing of papers presented at our meetings.

That we heartily approve of the plan originated in and advocated by the American Association of Economic Entomologists of coordinating and correlating plant quarantine activities through the creation of Regional Boards and a central or national Advisory Board.

That we urge further cooperation of various state entomological organizations with the Federal Departments in the solution of entomological problems, particularly the cotton boll weevil.

That we extend a hearty welcome to Prof. E. N. Cory of Maryland as the official representative of the American Association of Economic Entomologists.

That we have missed at this meeting the active participation of our president, Dr. W. E. Hinds.

That we sorrowfully regret the passing of our esteemed and beloved leader and co-worker, Dr. W. D. Hunter.

R. W. LEIBY
F. A. FENTON
J. H. MONTGOMERY

This report was adopted as read.

CONSTITUTION AND BY-LAWS OF THE SOUTHERN PLANT QUARANTINE BOARD

PREAMBLE

We, the plant quarantine and inspection officers of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Texas, in session at Atlanta, Georgia, on February 4, 1926 for the purpose of discussing quarantine and inspection problems pertaining to the promulgation and enforcement of our various regulations, believing uniformity of action to be conducive to better results in our work, deem it advisable to form an organization for our mutual cooperation and understanding. For this purpose we hereby adopt the following Constitution and By-Laws:—

CONSTITUTION

ARTICLE I

SECTION 1. NAME: This organization shall be known as The Southern Plant Quarantine Board.

SECTION 2. MEMBERS: This board shall be composed of the plant quarantine and inspection officers of the following states: Alabama, Arkansas, Florida, Georgia, Louisiana, Oklahoma, Mississippi, North Carolina, South Carolina, Tennessee and Texas.

ARTICLE II

SECTION 1. PURPOSE: It shall be the purpose of this organization to secure a greater mutual understanding, closer cooperation and uniformity of action for the efficient protection of our plant industries against plant pests.

ARTICLE III

SECTION 1. VOTING: Each state holding membership in this organization shall be entitled to one vote.

ARTICLE IV

SECTION 1. OFFICERS: The officers of this organization shall consist of a Chairman, a Vice-Chairman and a Secretary, to be elected annually.

SECTION 2. REPRESENTATIVES: There shall be elected two members to represent this organization on a National Plant Quarantine Board. These members shall be elected in alternate years and shall serve for a term of two years.

SECTION 3. EXECUTIVE COMMITTEE: The Executive Committee of this organization shall consist of the officers and the two representatives on the National Plant Quarantine Board and it shall function in all matters for the Board in the interim between the meetings.

ARTICLE V

SECTION 1. AMENDMENTS: The Constitution may be amended at any regular meeting by a three-fourths vote of the states represented, or at any special meeting, provided that the proposed amendment or amendments have been submitted to each member 30 days before the meeting.

BY-LAWS

1. When convened, this Board shall be governed by Roberts' Rules of Order.
2. Officers of this Board shall be elected by ballot.
3. The duties of the officers of this Board shall be such as are ordinarily performed by such officers in similar organizations.
4. The time and place of the annual meetings shall be determined by the Executive Committee.
5. Special meetings may be called at the discretion of the Executive Committee, and such meetings must be called on petition of four (4) or more of the member states.
6. The By-Laws may be amended at any regular meeting by a three-fourths vote of the states represented, or at any special meeting, provided that the amendment or amendments have been submitted to each member 30 days before the meeting.

An Entomological dinner consisting of fifty covers was served in Henry Grady Hotel on the evening of February 4. Dr. J. W. Folsom acted as Toastmaster. Short talks were made by different Entomologists and the entertainment was furnished by local talent and consisted of readings, vocal and instrumental solos.

THE SEASONAL HISTORY AND FOOD HABITS OF THE TOBACCO BUDWORM, *HELIOTHIS VIRESCENS* FAB., IN THE SOUTHERN TOBACCO-GROWING REGION

By F. S. CHAMBERLIN and J. N. TENHET, *Southern Field-Crop Insect Investigations, U. S. Bureau of Entomology*

ABSTRACT

This paper deals with the seasonal history and food habits of the tobacco budworm, *Heliothis virescens* Fab., in the southern tobacco-growing region. It is shown that *H. obsoleta*, the false budworm, is only rarely found on tobacco in this district.

H. virescens is usually present from the first of April until the middle of October, during which interval there are four broods.

Tobacco and beggarweed are the food plants of major importance. The food plants of minor importance are also mentioned.

INTRODUCTION

The budworm[1] is one of the important pests of tobacco, especially in the southeastern part of the United States. Excellent methods for the control of this insect on cigar tobacco were worked out by Morgan and McDonough[2] in 1917. Since that time additional studies have been made by the writers regarding the seasonal history and food habits of this species. The present paper summarizes these data.

Heliothis virescens ON TOBACCO

Literature on the subject is evidently responsible for the prevalent idea that *H. obsoleta*, the false budworm, is the most common species of budworm on tobacco in Florida. Many collections made in Florida and Georgia during the past seven years, however, have shown that this species is only very rarely found on tobacco in this region. Of several thousand budworm larvae collected from tobacco at Quincy, Florida, and bred to the adult form, only two specimens proved to be *H. obsoleta*. *H. virescens*, on the other hand, continues to be extremely abundant upon tobacco year after year.

In the tobacco-growing regions further north both species are found upon tobacco, but rarely in sufficient numbers to cause much injury. *H. virescens* has been recorded from tobacco as far north as Connecticut.

SEASONAL HISTORY

Under cage conditions, moths of *H. virescens* emerged at Quincy, Florida, from April 28th to June 11th. Field observations have shown, however, that a considerable number usually emerge previous to this

[1] (*Chloridea*) *Heliothis virescens* Fab.

[2] Morgan, A. C., and McDonough, F. L. 1917. The Tobacco Budworm and Its Control in the Southern Tobacco Districts. U. S. Dept. Agr. Farmers' Bul. 819.

time, so that tobacco which is set out during the first part of April is immediately infested. In some seasons eggs are deposited on the seed beds during March.

The first generation requires about 46 days for its complete life cycle, but the later generations may complete their development in a somewhat shorter period.

The first two broods of the budworm confine themselves almost entirely to tobacco. They overlap to a great extent, and their numbers are sufficiently large to keep tobacco fields thoroughly infested throughout their entire period of growth.

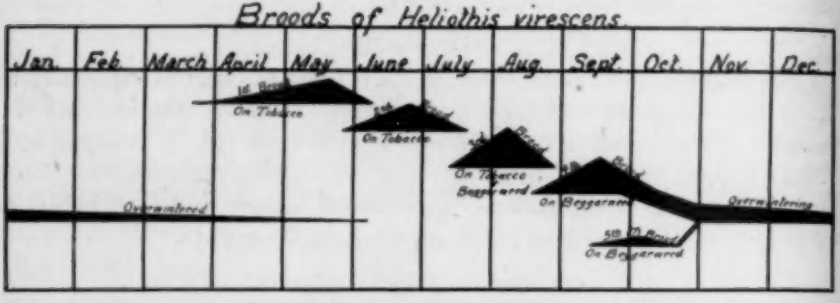

Fig. 37.—The seasonal history and food habits of the tobacco budworm, *Heliothis virescens* Fabr., in the southern tobacco growing region.

The third brood is present mainly during the latter part of July and during August. Individuals of this brood feed upon late tobacco and beggarweed,[3] which becomes abundant at this season of the year. Field observations indicate that there is a decided preference for beggarweed.

The fourth brood, which occurs during September and the early part of October, feeds almost entirely upon beggarweed, although some tobacco suckers[4] are usually present in the fields at this time. This last brood overwinters in the ground in the pupal state.

Although only the four main broods of *H. virescens* have been mentioned, there may be a partial fifth brood in this region. It also occasionally happens that a few scattered individuals may be found throughout the winter months.

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[3] *Meibomia* sp.

[4] This term refers to new leaves starting after the top of the main stalk has been removed.

Food Habits

Tobacco and Beggarweed

In years past, tobacco was supposed to be the only main host plant of the tobacco budworm. It has recently been found, however, that beggarweed is a second very important host in this region.

On tobacco the budworm feeds mainly on the terminal bud, as its name implies. Newly hatched larvae when migrating to the bud frequently stop and eat sparingly of the leaf surface, but this feeding seldom goes entirely through the leaf. Large larvae sometimes feed upon the upper leaves and frequently bore into the stalk. When the seed heads are formed the budworms congregate upon them and apparently prefer them to other portions of the tobacco plant.

The budworm feeds upon the various types of tobacco, showing no evident preference among them.

In this region beggarweed matures about the time tobacco is being harvested and the budworm promptly transfers its attention from tobacco to the beggarweed. Thus there is no appreciable break in the food supply. Observations indicate that beggarweed is the preferred host plant when available. As on tobacco, the seed heads are apparently preferred as food, although the foliage is fed upon to a limited extent. The similar appearing larvae of *H. obsoleta* are also found on beggarweed during the fall months in this region.

In the spring and early summer when the budworm is feeding on tobacco, practically all of the larvae are green or greenish-yellow in color. In the summer and fall, however, a distinct change is noticeable. The color becomes much more varied, with darker types predominating. The darker colored larvae are most frequently collected from beggarweed, the few specimens found on tobacco at this season usually retaining their light green coloring. This change in appearance is not due to the color of the body contents showing through the body wall, but is a distinct pigmentation of the skin. Since the majority of the larvae found on tobacco in the fall retain their green coloring, it appears that the change is not a seasonal variation. The darker colored larvae are very inconspicuous on the brown seed heads of beggarweed, as are the green forms on tobacco.

Host Plants of Secondary Importance

Aside from the two important hosts of *H. virescens* in this region, there are several others of lesser importance.

In the Virgin Islands this species is reported as a pest of okra. In this region, however, okra is only occasionally attacked by this insect.

In several instances larvae of the true tobacco budworm have been found feeding upon tomatoes. In each instance they were associated with *H. obsoleta*, and composed only a small percentage of the worms present.

In a number of instances *H. virescens* has been found attacking cultivated sweet peas. The larvae appear, however, to be unable to mature upon this food plant. When transferred to tobacco foliage they mature normally and complete their life cycle.

In addition to those already mentioned, there are several recorded food plants from which *H. virescens* has never been collected in this region, namely potato, cotton, chick-peas, ground cherry,[5] cultivated geranium, ageratum, and deer grass.[6]

Possible Host Plants

Numerous attempts have been made to carry this insect through its larval stage on various other hosts, including horse nettle,[7] English pea, cowpea, egg plant, and alfalfa. All of these attempts were unsuccessful. Larvae subsisted, however, for some time on cowpea and alfalfa.

AN IMPORTANT OUTBREAK OF INSECTS INFESTING SOY BEANS IN LOWER SOUTH CAROLINA

By C. B. NICKELS, *Assistant Entomologist, South Carolina Experiment Station, Clemson College, S. C.*

ABSTRACT

A severe outbreak of leaf devouring caterpillars occurred during the late summer and autumn of 1925 in fields of soy beans in the southern counties of South Carolina. The Otootan variety suffered much more than the other varieties of soy beans. Some other cultivated plants suffered to a less extent. The following lepidopterous species were conspicuous in the outbreak; velvet bean caterpillar, *Anticarsia gemmatilis* Hubner; Corn Ear Worm, *Heliothis obsoleta* Fabricus; Fall Army Worm, *Laphygma frugiperda* Smith and Abbott; Grass Worm, *Goniurus proteus* Linnaeus; and *Prodenia* sp. The losses caused, the plants attacked, and tests for control are discussed in this paper.

During an outbreak of leaf-devouring caterpillars in the southern counties of South Carolina in the late summer and fall of 1925, a loss of approximately 70 per cent was inflicted upon the Otootan variety of soy beans; other varieties of soy beans and certain other crop plants, suffered to a less extent.

[5] *Physalis viscosa.*
[6] *Rhexia virginica.*
[7] *Solanum carolinense.*

SPECIES OF INSECTS CONCERNED.—Our records indicate that fully 95 per cent of the larvae concerned in this outbreak were of two species; Velvet-bean Caterpillar, *Anticarsia gemmatilis* Hbn. and Corn-ear Worm, *Heliothis obsoleta* Fabr. Three additional species were present in the majority of fields and did a minor amount of damage, these being *Laphygma frugiperda* S. & A.; *Goniurus proteus* L.; and *Prodenia* sp. The relative numbers of the three which were most numerous on soy beans, velvet beans and peanuts are indicated in Table 1.

TABLE 1.—LARVAE ATTACKING LEGUMES.

Date of examination	Crop-plant	*A. gemmatilis* Hbn.	*H. obsoleta* Fabr.	*L. frugiperda* S. & A.
Oct. 8	Soy beans	53.87%	42.67%	
Nov. 3	Soy beans	98.68%	0.88%	
Oct. 14	Peanuts	87.14%	5.01%	7.00%
Oct. 14	Velvet beans	100.00%		

PERIOD OF INJURY.—Serious insect injury to soy beans was first observed by growers September 20th. The maximum amount of damage occurred between September 25th and October 20th. Larvae of the velvet bean caterpillar continued to cause injury in many fields until the crop was harvested. This is indicated in Table 1 by the preponderance of this species in soy beanfields in the examination of Oct. 3rd, when the Corn Ear-worm had almost disappeared.

CLASSES AND VARIETIES OF LEGUMES ATTACKED.—The estimated percentage of damage that occurred to soy beans is given for the following varieties:—Otootan 70%, Biloxi 5%, Mammoth Yellow 1% or less, Laredo 1% or less, Ebony and Wilson, no appreciable damage. All of the varieties of soy beans except Otootan were nearly mature before the beginning of important insect injury.

On soy bean plants all parts of the leaves except the midribs and larger veins were devoured. Larvae ate holes through the pods and devoured the seed of soy bean plants in many fields. Larvae of the velvet bean caterpillar devoured the leaves of velvet beans, but the seed pods were sufficiently mature to escape injury.

The leaves of peanut plants were devoured by larvae of the velvet bean caterpillar, corn ear worm and fall army worm.

MONETARY LOSSES.—It is estimated that the loss resulting from the destruction of Otootan soy beans exceeded $500,000. More than 60,000 acres of Otootan soy beans were planted in the counties of Orangeburg, Calhoun, Richland, Sumter, Hampton, and Aiken and the average reduction in yield of this variety was estimated at seventy per cent.

THE VELVET BEAN CATERPILLAR (*Anticarsia gemmatilis* Hbn.) This insect has been studied in Florida by J. R. Watson,[1] who states that it overwinters in Cuba and possibly in southern Florida. It is a serious pest of velvet beans in Florida, attacking both leaves and seed-pods. Yet even in Florida it did not attract notice as a pest of soy beans until 1925, the same year as our South Carolina outbreak. Mr. Watson established that the species is migratory. In Florida a fungous disease called "cholera" is an important natural enemy of the insect.

In South Carolina some of our growers in 1925 reported that two years previously (in 1923) soy beans in some fields were noticeably injured by larvae which they believed to be identical with the velvet bean caterpillars of 1925.

A PREDACIOUS ENEMY.—We found the large carabid beetle, *Calosoma sayi* Dej. to attack the pupae of the Velvet Bean Caterpillar in the soil. This beetle was abundant in many soy bean fields in the southern part of South Carolina during the outbreak under discussion, and as it is known to be of voracious habits it is probable that it was of considerable beneficial importance. Quite possibly it also fed on the larvae.

CONTROL OF THE VELVET BEAN CATERPILLAR

Experiments were conducted along the following lines:—Cage poison tests, plant toxicity tests and field poison tests.

CAGE POISONING TESTS.—In cage tests the effectiveness of the following poisons were studied:—Calcium arsenate, and calcium arsenate mixed with lime in proportions of "1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, and 1-9." Lead arsenate, lead arsenate mixed with lime in proportions of 1-2, 1-4. Lead arsenate spray in proportions of two pounds and four pounds lead arsenate to 50 gallons of water.

Data from experiments indicate that poisons less concentrated than calcium arsenate one part and lime four parts will not kill a high percentage of the larvae of the velvet bean caterpillar. A mixture of calcium arsenate and lime stronger than one to four is considered unsafe to apply on soy beans.

The stage of growth of the larvae is an important factor in determining the strength and quantity of poison required for control. Larvae of the velvet bean caterpillar less than ¾ of an inch in length can be readily poisoned with the "1 to 4" strength, while larger larvae are extremely difficult to poison.

[1]Watson, J. R., 1916, "Control of the Velvet Bean Caterpillar," Univ. of Fla., Agr. Exp. Sta. Bull. 130.

PLANT TOXICITY TESTS.—The effect of various poisons applied on soy beans in toxicity tests is given in Table 2.

TABLE 2.—INSECTICIDES PLANT TOXICITY TESTS

No apparent injury resulted from applications listed below	Apparent injury resulted from applications listed below
1 part Calcium Arsenate 4 parts Lime	Calcium Arsenate
1 part Calcium Arsenate 5 parts Lime	1 part Calcium Arsenate 1 part Lime
1 part Calcium Arsenate 6 parts Lime	1 part Calcium Arsenate 2 parts Lime
1 part Calcium Arsenate 7 parts Lime	1 part Calcium Arsenate 3 parts Lime
1 part Calcium Arsenate 8 parts Lime	Lead Arsenate (dust)
1 part Calcium Arsenate 9 parts Lime	
1 part Lead Arsenate 2 parts Lime	
1 part Lead Arsenate 4 parts Lime	
2 lbs. Lead Arsenate 50 gallons water	

METHOD OF CONDUCTING TESTS:—The insecticides tested were applied on three rows of soy beans (Otootan variety) each 100 feet in length. The tests were duplicated in every instance in which the insecticides are reported as not having injured soy bean plants.

It is realized that some of the insecticides reported as injurious may not be injurious under certain weather conditions; while some of the insecticides indicated as safe to apply on soy beans may cause injury under adverse weather conditions. Heavy dews at the time poison applications are made has a tendency to increase arsenical burning. Moisture on plants increases the release of water soluble arsenic. Under dry weather conditions arsenicals with a comparatively high water soluble arsenic content may be used without the occurrence of burning. The degree of maturity of plants is a factor in determining the amount of arsenical burning that may occur. The plants used in tests reported in this paper were nearly mature.

FIELD POISONING OPERATIONS.—Many fields were visited which had been treated with poisons by growers. While these examinations served to confirm the conclusions which were reached from our more restricted tests, some of the data needed for accurate experimental work were

lacking, so no attempt is made to give an elaborate analysis of their results.

The Probability of the Velvet Bean Caterpillar and the Corn Ear Worm Attacking Soy Beans in 1926

It is unlikely that the velvet bean caterpillar will survive the winter in South Carolina. The larvae usually pupate less than one inch below the soil, and apparently succumb easily to severe weather. Hence the possibility of an outbreak of velvet bean caterpillars seems to depend largely upon conditions being favorable for the multiplication of this insect in Southern Florida, and upon favorable winds to enable a large number of the moths to reach this state in time to do damage. In this respect the case is apparently similar to that of the Cotton Leaf-worm which was also present in some South Carolina cotton fields during the period of this outbreak.

The corn ear worm is an important enemy of several plants in this state. During the year 1925 the attacks of this insect on corn, cotton, tomatoes and soy beans, caused severe losses.

It is probable that the corn ear worm will be an important pest in 1926, for enormous numbers of this insect pupated during the fall of 1925. The extent of damage that may result from the attacks of this insect will depend largely upon winter survival and the degree in which conditions are favorable for their multiplication next spring.

METAL BARRIERS AS PROTECTIVE DEVICES AGAINST THE SAW-TOOTHED GRAIN BEETLE[1]

By J. C. Hamlin, *Associate Entomologist*, and W. D. Reed, *Assistant Entomologist, Stored Product Insect Investigations, U. S. Bureau of Entomology.*

Abstract

Laboratory experiments reviewed herein indicate that, under certain conditions, certain types of metal barriers may afford to raisins a high degree of protection from the saw-toothed grain beetle, *Oryzaephilus surinamensis* Linn.

Introduction

In recent years the saw-toothed grain beetle[2] has been a major factor in the infestation problems of raisin packers. Certain plant practices and economic conditions have operated to permit the establishment of very heavy infestations of this species on packing-plant premises throughout the raisin-producing area of California.

[1]This paper was prepared in December, 1925.

[2]*Oryzaephilus surinamensis* Linné.

PLATE 9

Experimental models of barriers. Left—Angle Barrier. Right—Arc Barrier. The barriers were elevated as shown merely to facilitate the making of observations.

The raisin crop, after delivery by the grower, is stored in stacked boxes beneath temporary sheds constructed in the plant yards. These storage quarters, being protected only from the weather by metal roofs, are easily invaded by the local beetle infestation. During the processing of one of these stacks the beetles are largely separated from the fruit, but their freedom to spread into other stacks has perpetuated the infestation. Thus, the basic step in combating this raisin pest resolves itself into the control of the storage infestation.

Two complementary measures designed to accomplish this result were outlined in a recent paper.[3] The first, aiming at minimizing the plant infestation by destruction of the insects so largely collected in trash during processing, was successfully developed and adopted during the past year. The second phase of control contemplates the protection of storage sheds from this minimized infestation through the agency of metal barriers.

The barrier principle is based upon the observed non-flight of the saw-toothed grain beetle, supported by preliminary experiments. However, pending the acquisition of more evidence of the species' non-flight, experimental application of the principle to practical conditions has been postponed.

In the meanwhile a pertinent inquiry into the underlying principles involved in these devices has been made. Small laboratory models were used in this study. This paper is, therefore, limited to an analysis of the barriers with a view to determining, through observation of the reactions of individual beetles to the various surfaces, the degree to which the several features contribute to the total protection provided by such devices.

The Metal Barriers

The two types of protective devices, constructed of 24 gauge galvanized sheet iron, are the arc and angle barrier. Each consists of a vertical portion 12 inches high with an over-hanging part directed away from the space to be protected. The upper part of the arc barrier consists of a half-circle of a 4-inch diameter, whereas in the angle barrier it is reflexed to form a 20-degree angle with the vertical plane. All corners are spliced to preserve such characters entirely around the barriers. These features, as embodied in the experimental models, are shown in Plate 9. The superimposed boxes contained a layer of raisins, and the beetles were liberated on the sand at the bases of the barriers.

[3]Control of the Saw-toothed Grain Beetle in Raisins: A preliminary Report, by Hamlin, J. C. and Benton, C., Jl. Ec. Ent., V. 18, No. 6, 1925.

In applying either of these devices to the large storage stacks, containing from one to two million pounds of raisins each, the vertical portion would be sunk 4 inches into the ground, with the over-hanging edge directed away from the stack. Thus, in position, the barrier would surround the storage shed, being immediately outside of the supporting timbers.

General Observations on Beetle Reactions

The Arc Barrier. When released, perhaps half of the beetles crawled away from the barrier, either falling over the edges or crawling on the sides or in the cracks of the supporting structure. The remainder immediately began to ascend the vertical surface of the barrier. Although some few climbed at a normal rate of speed, it was evident that the majority experienced some difficulty in crawling on the smooth metal surface and that the slower moving ones slipped back less frequently. Those falling from the vertical surface landed on the sand whence they had started the ascent and usually resumed climbing, with, however, a gradual diminishing of their numbers. After the end of the first hour the majority of the beetles would be found on the more shaded side of the barrier.

When the beetles reached the concave facing of the barrier, their reactions were multiple. The great majority restricted their activities to its highest part, either remaining motionless for long periods or intermittently moving short distances over zig-zag courses at about the middle of the inverted trough. Some crawled back and forth on the overhanging half of the concave facing, always orienting themselves obliquely to the edge. It was noted that the beetles almost invariably halted when about one-half inch from the edge, turning to parallel it, returning toward the zenith, or approaching the edge after some hesitancy. A very few, after reaching the edge or the convex surface, turned back to the concave facing. A small number passed the edge, ascended the convex surface, and reached the box of raisins.

From the base of the barrier to the zenith of the concave surface and downward to the overhanging edge the number of beetles constantly decreased. A few failed to reach the top of the vertical surface; others fell before attaining the zenith of the concave; still others fell from the zenith, at various distances from the overhanging edge, from the edge itself, and even from the convex surface after having passed the edge.

This retarding effect of the arc barrier is largely attributable to three regions of the concave surface. First, approximately three-fourths of the beetles which reach the highest part of the concave progress less than

one inch toward the overhanging edge. This result is to be ascribed not so much to the falling of beetles as to a general disinclination to proceed along the descending surface, thus impinging upon the negative responses of the species to light and gravity. Second, the descending surface from the zenith to the overhanging edge proved to be operative in greatly reducing the number travelling toward the edge. Third, the edge itself prevented the further passage of a large proportion of the individuals reaching it.

THE ANGLE BARRIER. The general reactions of the beetles to the angle barrier were similar to those recorded for the arc barrier, although the angle barrier permitted fewer beetles to reach the edge. The outstanding differences appear to be due to the characters of the zenith and of the surface descending to the overhanging edge. The narrow groove which constitutes the zenith of this barrier operates not only to reduce the number of beetles which reach the zenith from the vertical surface, but also to reduce the number which successfully transfer from it to the obliquely descending plane. Again, this sloping plane appears to be more precarious than the rounded descent of the arc barrier. The edge itself produced reactions similar to those of the arc barrier.

EXPERIMENTAL DATA

Since the beetles encountered no major deterrent prior to reaching the zenith of the under surface, the recording of happenings to individual beetles was purposely restricted to those which were situated at or beyond the zenith. Thus the tabulated results pertain only to representatives of the more successful individuals. Without great detail the multiple movements of each beetle cannot be shown, and the following table gives only the ultimate disposition of those observed. The observational period in these experiments immediately followed the liberation of the beetles.

From Table 1 it will be seen that, for each corresponding stage of progress on the two barriers, a larger percentage of beetles fell from the angle barrier, and that a smaller number reached its overhanging edge. The reaction to the edge is shown to be the same for both barriers since half of those reaching it did not reach the box of raisins. The numbers of individuals passing the edges of the angle and arc barriers represent percentages of 6.5 and 14.5, respectively, of the total number observed. Based on the estimated total number of beetles attempting to climb the barriers, these numbers become less than 0.5 per cent and 1.0 per cent, respectively.

TABLE 1.—HAPPENINGS TO INDIVIDUAL BEETLES AFTER ATTAINING THE HEIGHT OF THE UNDER SURFACE OF THE BARRIERS[1]

Expt. No.	Date 1925	Mean temp. Fahr.	Mean rel. humid. %	Precipitation	Sky: % sunshine	Type of barrier	No. of beetles liberated	Length of observational period (min.)	Ultimate disposition of beetles observed: No. of individuals observed	No. fell from highest point	No. fell between zenith and edge	No. reached edge	No. passed around edge and climbed upper surface
1[2]	9– 9	81[4]	30[4]	0	—	arc	500	110	9	5	4	1	0
2	10–23	70	45	0	100	arc	500	120	19	2	11	7	4
2	10–27	78	28	0	100	arc	500	150	18	2	11	5	4
4	10–28	78	27	0	100	arc	500	150	16	5	10	2	0
5	10–29	73	37	0	100	arc	500	150	21	4	10	11	4
Subtotal						arc	2500		83	18	46	26	12
6[3]	9–11	85	27	0	—	angle	500	82	9	2	7	0	0
7	9–12	76	39	0	100	angle	500	115	14	8	4	2	1
8	10–26	79	25	0	100	angle	500	150	18	7	9	3	1
9[3]	10–27	67	50	0	100	angle	500	150	20	10	9	2	1
10	10–30	73	36	0	100	angle	500	150	16	8	5	3	2
Subtotal						angle	2500		77	35	34	10	5

[1]The meteorological data in this table were supplied by Mr. W. E. Bonnett, Weather Bureau Office, Fresno, California. The records were taken at an elevation of 89 feet above the ground.

[2]Conducted in a darkened room. Large pans containing water covered the barrier to prevent beetles falling on it from the ceiling. All other experiments were conducted in the open on the north side of a building; the barriers were in solid shade except for the last few minutes of those tests which terminated after 5:00 p. m.

[3]This experiment alone was made in the forenoon and the temperature and relative humidity figures pertain to that portion of the day.

[4]Mean derived from readings taken at local noon and at 5:00 p. m.

TABLE 2A.—RESULTS OF END-POINT EXPERIMENTS SHOWING NUMBER OF BEETLES GAINING ACCESS TO RAISINS SURROUNDED BY BARRIERS

	Arc barrier				Angle barrier			
Number of beetles used[1]	No. of Expt.	Duration of experiment hr.	min.	Number of beetles in raisins inside barrier at end of experiment	No. of Expt.	Duration of experiment hr.	min.	Number of beetles in raisins inside barrier at end of experiment
500	1	18	30	2	11	18	22	3
500	2	24	00	4	12	23	15	10[2]
500	3	24	00	1	13	19	30	2
500	4	23	45	4	14	24	00	0
500	5	24	15	3	15	24	00	0
500	6	24	00	1	16	24	00	0
500	7	23	50	0	17	23	50	0
500	8	23	05	3	18	23	05	1
500	9	25	00	0	19	23	00	1
500	10	24	00	1	20	25	00	3
5000				19				20

[1]The numbers of this column apply independently to both the arc and the angle experiments.

[2]Due to a misunderstanding relating to the box intended for use inside this barrier, this figure is believed to include a number of beetles that were on the box when placed.

TABLE 2B.—CLIMATIC CONDITIONS APPLYING TO THE END-POINT EXPERIMENTS RECORDED IN TABLE 2A.

Exp. No.	Date (1925)	Temperature Fahr.[1] Max.	Min.	Relative humidity[2] 5 p.m.	5 a.m.	Precipitation	Sky: % sunshine	Wind Max. Vel. (m.p.h.)	Direction Max. Vel.
1[3]	Sept. 9–10	84	57	23	70	0	100	18	NW
2, 19	Oct. 23–24	74	52	42	72	0	100	12	NW
3, 14	Oct. 27–28	82	52	30	66	0	100	11	NW
4	Oct. 28–29	82	52	28	72	0	100	8	NW
5	Oct. 29–30	78	50	30	66	0	100	14	NW
6, 16	Oct. 20–21	82	55	30	85	0	100	7	NW
7, 17	Oct. 21–22	85	54	22	72	0	100	6	N
8, 18	Oct. 22–23	81	47	27	81	0	95	13	NW
9, 20	Oct. 24–25	78	51	33	79	0	100	9	NW
10, 13	Oct. 26–27	83	52	23	73	0	100	6	NW
11[3]	Sept. 11–12	89	57	20	72	0	90	26	NW
12	Sept. 12–13	80	55	35	79	0	100	16	NW
15	Oct. 30–31	77	48	34	70	0	100	14	NW

[1]The maxima and minima relate, respectively, to the dates the experiments were started and ended, being actually the maxima and minima of the period covered by the test.

[2]The 5:00 p. m. and 5:00 a. m. records of relative humidity pertain, respectively, to the dates the experiments were started and ended. These figures represent the nearest approach to maxima and minima provided by available records.

[3]Conducted in darkened room of laboratory.

Table 2A presents the results of end-point experiments[4], or those in which was recorded only the number of beetles found in the raisins at the conclusion of the experiment. Since all of the detailed observations were necessarily made during the day, each of these experiments included an overnight test calculated to reveal any differences in the protective values of the barriers in the absence of light.

It was pointed out above that nearly all individuals halted when about one-half inch from the edge of either barrier. This constant reaction was then attributed largely to the negative phototropism and to a lesser extent to the negative geotropism of this species. Since, however, the elimination of the light factor during the overnight exposure included in the end-point experiments was not reflected in lessened effectiveness of the barriers, it appears that the phototropic response may not have caused the characteristic hesitancy of the beetles as described. On the other hand it is conceivable that this reaction was indeed due to the influence of light and that, during the night, the lower temperatures so offset that factor by producing inactivity of the beetles that the result was not affected.

This table shows that 0.8 per cent and 0.76 per cent of the approximate total number of beetles attempting to climb the barriers reached raisins protected by the angle and arc barriers, respectively. Through the possibility of error cited in Table 2 the advantage is here shown in favor of the arc barrier, contrary to the relative merits shown by both the general and the detailed observations.

The above tables and general discussion of the reactions of the beetles to the barriers indicate that both devices possess protective values against the saw-toothed grain beetle. Furthermore, the angle barrier appears to be more effective than the arc barrier.

THE ACALYPHA FLEA BEETLE (*CREPIDODERA ATRIVENTRIS* MELSH.)

By W. V. Balduf[1]

Abstract

This small brown flea beetle has long been known to eat wild *Acalypha*, and recently did marked damage to ornamental species of this genus. The first three stages are spent in the ground about the plants, the larva feeding on the roots. Two generations are believed to develop each year at Urbana, Illinois, and the winter is passed

[4]Numbers 1–5 and 11–15 of this table actually represent the end-points of experiments 1–5 and 6–10 respectively, of Table 1.

[1]Contribution No. 103 of the Entomological Laboratories of the University of Illinois.

in the adult stage. A small hymenopterous parasite was obtained from the adult insects. Many details are given to support the above phases of the life history, and other features also are discussed.

In the summer of 1922, a small brown flea beetle did severe damage to *Acalypha* in the gardens of the floriculture department of the University of Illinois at Urbana. It was observed again during the summer and fall of 1925, when it occurred in small numbers on the cultivated *Acalypha* and commonly on the wild *A. virginica*. Mr. H. S. Barber of the Bureau of Entomology identified it as *Crepidodera atriventris* Melsh.

It was described by Melsheimer (1) in 1847 from Pennsylvania. Forbes and Hart (2) reported it on sugar beets, and these writers include a record by F. M. Webster who took it on buckwheat. It seems to have been of little or no consequence to these crops. In 1924, Chittenden (3) published a half-page article which embodies a review of the earlier papers and states his own observations. Most of the essential facts about its life history do not appear. For this reason, and on account of its economic importance, a description of its habits and annual development as determined at Urbana in 1925 should be of value.

Food Plants, Distribution and Injury

Presumably the presence of *C. atriventris* on sugar beets and buckwheat was incidental. The usual and perhaps typical food plants of the species are the members of the genus *Acalypha*, a euphorbaceous group. Gray's Manual of Botany, p. 543, lists three wild species of rather wide distribution, of which only *A. virginica* has been recorded as frequented by this beetle. It will perhaps be found to attack also the other wild species. *A. virginica* is a common weed in both wooded areas and open fields which, with its geographical distribution, would seem to indicate that the beetle occurs in many of the states. Both *A. virginica* and the beetle occurred in the University forest at Urbana, and in woodlands at Oakwood, Illinois in 1925. The beetle has been definitely reported from Massachusetts to Maryland, and from Florida (4), and Chittenden (3) has known it for years and records it from Washington, D. C. Melsheimer (1) had it from Pennsylvania, while Forbes, Hart and Webster (2), and the writer took it in Illinois.

Its reputation as a species of economic importance is of short duration. In 1924, Chittenden (3) discovered it "depredating on useful plants," *Acalypha wilkesiana*, at Washington, and the writer first saw it abundant on cultivated *Acalypha* on June 22, 1922, and on subsequent dates during that summer, and somewhat less commonly from June 16

to September 30 in 1925, on *A. marginata* and *A. tricolor*. They were in general distinctly more numerous on *tricolor* than on *marginata*.

The injury is like that done by other small flea beetles. The foliage is riddled with numerous small more or less circular holes which entirely penetrate the blades in more severe instances. One-half the leaf surface had been eaten away on wild plants in June, 1925. *Acalypha* is grown to a limited extent at the University for the ornamental colors of its leaves. As such they are used both as bedding plants and as borders for beds of flowering or other foliage plants. Hence, the damage to the leaves not only affects the growth of the plants but spoils directly their decorative value as well. In 1922, the plants were grown as borders and were so badly riddled that some of the leaves dropped off, and the plants lost their vigor and brightness. In the summer of 1925 they were less common and did but little damage to the plants which in this instance constituted the entire beds. However, in the same year in the University forest, the wild plants, which were one to two inches high on June 16, and occurred in large numbers, harbored many beetles and had been severely attacked at that time. The very dry weather of July 1925 seemed to be unfavorable to the development of large numbers of beetles of the first new generation. As a result, the sets of leaves sent out during July were decreasingly molested. The greater quantity of foliage of the larger plants also rendered the results of their feeding less conspicuous than on the tiny seedlings attacked earlier when the insect was present in maximum numbers. Chittenden (3) found it damaging plants at Washington during May and June. Indications are therefore that the severest damage to both the wild and cultivated species of *Acalypha* is to be expected at Urbana, Illinois from about June 15 to July 15.

Life Stages

The egg is light yellow in color, and 0.42 mm. long by 0.21 mm. in greatest diameter, or roughly 2/5 by 1/5 mm. In shape it is oval, or broadly and equally rounded at each end. In low magnification the surface is shiny and appears to be unsculptured, but seen in greater detail proves to be finely marked with shallow furrows that break the surface into numerous minute, flat spaces arranged in no definite plan. The spaces are subequal in size, and subquandrangular in shape.

The larva is described by Chittenden (3) as "an almost exact counterpart of that of *Epitrix*, extremely delicate and of a clear white color." The larva in various stages of growth was seen by the writer. In all sizes it is whitish in color for most part, and slender, with the typical

pair of anal prolegs. When newly hatched it is 0.79 mm. long and its width is quite uniformly 0.16 mm. throughout. The anterior two-thirds of the dorsum of the head is medium brown, the posterior third dusky, and the anal plate also moderately dark. Bristles in sparse numbers stick out from the side margins of the whole body, and from the dorsum. Eight conspicuous hairs radiate from the upper margins of the anal segment.

The mature or almost mature larvae were 3.01 mm. to 3.5 mm. long with a diameter of approximately 0.40 mm. The head capsule is light brown in background, but has a dorsal longitudinal line of darker brown interrupted midway by a shallow depression. The darker brown shade also occurs on a transverse space anterior to the antennae, at the base of the mandibles, and the lower side margins of the head. The bases of the thoracic legs are ringed in brown, and the legs otherwise bear a few miscellaneous brown spots. There is a row of four flaxen-colored hairs on the hind margin of the dark brown spaces located anterior to the antennae, and a few such hairs on almost all aspects of the body.

In the prepupa state several individuals had shortened and thickened to 1.95 mm. and 0.65 mm. respectively. The body was white and brown as in the larva, and curled up moderately at each end.

Five pupae were found in the earthen cases. The antennae and legs are disposed as in pupae of other Chrysomelidae and the body has the same general form and whitish color. They occurred in several states of development, one being entirely white, another having eyes pink, and others with eyes, mandibles and certain hair-tips turning brown.

The description of the adult is a supplemented modification from that of Melsheimer (1). Dull rufous; abdomen and under surface of the metathorax blackish; elytra striate-punctate; dimensions 1.55 to 1.71 mm. long by about 1.22 mm. at the widest point; short ovate, glossy. Head impunctured; palpi with the last joint dusky; antennae slender, testaceous; eyes black; thorax short transverse, narrower than the elytra, with the sides feebly rounded; moderately convex; very minutely punctured; transverse groove profound, retracted at both ends; elytra convex, striate-punctate; punctures obsolete towards the apex; sides arcuated; beneath blackish, or dark reddish brown; feet testaceous.

Development and Habits of the Stages

In this study, beetles were caged in vials containing food and a bit of soil to obtain eggs and small larvae. Soil from about the bases of *A. virginica* in the woods was removed for examination to find the eggs, larvae and pupae in their natural environment. The limited rearing

accomplished was done in small tin boxes with a bed of plaster of Paris solidified in the bottom.

The eggs are dropped or inserted in the soil in a miscellaneous manner. Many lie singly, but masses containing two to five were found in vials and in nature. The beetle seems to enter the soil to oviposit when small crevices, resulting from drought, occur. This is indicated by the presence of eggs a few millimeters below the ground surface in close proximity to such openings. They were sometimes attached to minute fibers, perhaps the rootlets of *Acalypha*. Eggs laid between July 11 and 14 hatched from July 21 to 24. These limited records indicate that the incubation period is about ten days.

The hatching larva emerges through a slit across the apex of the egg. The slit extends about two-fifths the length of the egg. Although the larva comes out head first in normal instances, it was observed once to be capable also of issuing caudal end first. In this case the cephalic end of the egg lay close against a bit of soil which seemed to block exit from that point. The larva used its prolegs for holding to the external surroundings and thus aided itself in backing out, which act required more than forty minutes. The larva had extruded one-sixth of its length when it was discovered.

Plantlets of wild *Acalypha* with the original soil kept intact about their roots were brought to the laboratory for study with a five inch reading-glass and low power binocular. Both eggs and larvae came to view in this way. The larvae were distributed from a few millimeters to an inch deep in the soil about the plant roots. They eat the rootlets, some in the proximity of the larvae having been cut off and in part consumed. Although they were not looked for about the rootlets of cultivated plants, the larvae probably attack these also. In cages, the larvae consumed the midribs of *Acalypha* foliage, as well as small portions of the leaf blade. Indications are that this stage lasts about two weeks in the summer months. The prepupal period approximated two to three days, according to the several steps in the transition from larva to pupa represented among a series of transforming larvae taken simultaneously.

Several pupa cases were found, all lying about one-half inch below the soil surface close to the bases of the *Acalypha* plants. The earthen cell in which this stage is spent is oval in shape and measured 1.85 mm. long by a maximum thickness of 1.05 mm. A mature larva released on a white card, when prodded, exuded two droplets of gluey substance from the head and the exudate hardened within one minute. When probed,

it snapped apart, indicating its brittle texture, and its close similarity to ordinary glue. Obviously this material is the means of adhering the particles of soil that compose the pupal cell.

Pupae and transforming larvae taken in various states of development on July 14, 1925 became adult from July 17 to 21. Accordingly, the youngest individuals of the lot,—namely the larvae in the act of turning to pupae, required one week to pass through the pupa stage and become normally active as adults. The newly emerged adult is distinctly lighter brown than beetles several days old. The adult insect is seen commonly feeding and mating on the upper or lower surfaces of the leaves, but when disturbed they jump away and crawl about on the soil or other plants among which the *Acalypha* grows. They also occur on the ground beneath the plants, especially during the time of oviposition. On cool days and on very hot days and in wet weather they sought the shelter of the *Acalypha* leaves.

The Life Cycle and Generations per Year

The records above and others of the same kind make it possible to generalize sufficiently to construct a tentative life cycle and annual history. During the months of June and July the egg stage was ten days, the larval period about two weeks, and the duration of the prepupa and pupa conditions totalled approximately ten days more. Hence, an individual *C. atriventris* required about 34 days or almost five weeks to develop from the instance of oviposition to the adult state. In the summer season, mating and egg-laying by the new beetles would normally be expected within a week after they leave the pupal cell. A complete cycle would therefore be passed in nearly six weeks in optimum growing weather.

The evidences available indicate that two generations develop in a year, and that the insect winters as adult. Two of twenty-five adults taken on September 15, 1925 lived in vials until November 7. However, under natural conditions these beetles would have lived over the winter. This is deduced from the facts that none of them mated and that adults were collected by Forbes and Hart (2) in December and March.

Among the first beetles discovered on *A. virginica* on June 16, 1925, good numbers were in copulation. The plants were only an inch to an inch and a half high, and the great extent to which they had already been riddled showed that the beetles were there from the very date the seedlings appeared through the ground. Eggs and almost mature larvae

were obtained commonly from the soil about plants on June 17 and 18. The eggs from which the larvae hatched were therefore laid at least three weeks previous or about May 23. Hence, the earliest mating began at the latest on May 20.

Beetles in cages laid eggs in good numbers on June 18 to 23. Adults were still common in a woods near Oakwood, Illinois, on June 25. The scarcity of beetles in the university woods and on the cultivated plants from July 1 to 16 indicated that the hibernated beetles were dying, but some individuals probably survived these dates and oviposited thereafter.

Larvae of the first generation in various instars are known to have occurred in the woods from June 17 to July 1. On the latter date, fifteen individuals three-fifths or more grown were obtained. This was the largest number taken at any one time during the summer in one quart of soil and plants, and probably represented the numerical climax of the first new generation. The almost mature larvae taken June 18 were due to become adults about July 1. Of the larvae taken on July 1, two pupated on July 2, and on July 14, and eight pupae of various ages had developed in the woods. Adults came from the latter lot from July 17 to 21. Eggs deposited in good number by the overwintered beetles on June 23 gave rise to adults on about August 1, according to the duration of the several developmental stages. Evidence thus indicates that first generation adults appeared at least from July 1 to August 1 or later, with maximum numbers present near the last of August. This conclusion is supported by the noticeable increase in numbers of adults on July 11, and more particularly on July 16 and 27, and August 4, the largest number having been present on the last date.

The exact beginning of the second cycle can not be designated. The first adult of the first generation was probably ready to oviposit on July 31. There is obviously some overlapping of the first and second generations, as indicated by the table below. Adults available in small numbers on July 11 had deposited many eggs in vials on July 14, and others on July 16 and 21. Beetles obtained on August 14 produced eggs the next day. But first generation adults were already abroad by June 26, hence some second generation eggs had been laid no later than July 1. The first adults of the second cycle probably did not appear before August 10, and continued to come as late as October 15. A few large larvae were taken from the woods soil on August 13. These probably represented the second generation. The largest number of beetles that were found subsequent to the large number present in the spring,

occurred chiefly on the cultivated acalyphas on September 15. Numbers of these individuals confined together more than a month showed no inclination to mate. The further fact that some survived until November 7 also tends to show that they were beetles of a second new generation. Inasmuch as the first new beetles are known to have reproduced, they could not, according to the general facts in the habits and development of other Chrysomelidae, have lived into November, and especially without showing further inclinations to mate during September and October. The duration of the life cycle during June and July being only five weeks further corroborates the probability that a second generation arises in latter July, August, and September.

The accompanying table summarizes the duration of each stage for the two generations, based partly on estimate and in part on observation. The dates are to be interpreted as signifying that, for example in the instance of the first generation eggs, the first eggs were laid on about May 23 and the last probably hatched shortly after July 10.

ESTIMATED DURATION OF THE STAGES

	Egg	Larva	Pupa	Adult
First generation	May 23–Jul. 10	June 2–Jul. 25	June 16–Aug. 5	June 26–Aug. 30
Second generation	Jul. 1–Sept. 10	July 11–Sep. 30	Jul. 31–Oct. 10	Aug. 10–Jul. 1

SOURCE OF THE BEETLES ATTACKING CULTIVATED PLANTS

The wild food plant, *Acalypha virginica*, grew approximately a quarter mile from the cultivated species. The interval between them is devoid of *Acalypha*, hence the beetle must fly a comparatively long distance if it reinfests the ornamental plants anew every year. *A. tricolor* and *A. marginata* were transplanted to the outdoors on May 22, 1925, which is quite as early as the wild species appears above ground. The duration of the wild and cultivated species in the fall is practically equal. Both were severely injured by frost on October 11, but continued to have some succulent living leaves a few days later. The development of the life cycles is as much favored by the ornamental as by the wild species, and there is not much room for doubt that *Crepidodera atriventris* passes all stages in the flower garden just as it does in the woods. Therefore, the beetle probably attacks the ornamentals in both of its generations. It is also quite unlikely that yearly migrations from the wild to the cultivated plants occur.

NATURAL ENEMY

On July 16 and 22, a total of three small white hymenopterous larvae appeared in vials containing adult *C. atriventris*. Accompanying each

larva was a dead beetle whose body had been greatly disrupted. The abdomen was almost torn from the thorax, an elytrum was usually rent from the body, and the dorsal abdominal wall collapsed. Without question the white larvae had developed in the beetles and killed their hosts during emergence. The mature parasite grub is robust, being 1.04 mm. long and 0.478 mm. in maximum width. Two of them had produced considerable silk in attempts to make a cocoon in the bare vial, but failed to complete the cases, and adults were not obtained. Although a parasite has not been known heretofore to attack *C. atriventris*, other flea-beetles of nearly its size,—*Epitrix parvula* (5) and *E. cucumeris* (5) (8), the western cabbage flea beetle, *Phyllotreta pusilla*, and *P. vittata* (7), and others have been reported as hosts of a similar larva. Cameron (6) gives an account of his observations on its relations with *E. cucumeris*. The parasite which Cameron had, proved to be a *Perilitus*, which Viereck named *epitricis*. It may be that this is the species found infesting *Crepidodera atriventris*.

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THE SQUASH BEETLE IN ARIZONA, OCCURRENCE AND PROBABLE MANNER OF INTRODUCTION

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ABSTRACT

During 1921 the squash beetle (*Epilachna borealis* Fab.) appeared in the vicinity of Douglas, Ariz. It slowly extended its range during the period 1921 to 1924 until it covered about 65 square miles. During 1925 the insect was not found within the previously infested area, and it is believed that a deficiency in precipitation, combined

with an increase in the mean temperature, may have been responsible for the disappearance of the pest. The beetle differs from the Eastern form in being somewhat smaller in size and in the absence of marking on the prothorax. The dots on the elytra are also smaller.

A small-spotted, pale variety of the squash beetle (*Epilachna borealis* Fab.) was first discovered[1] in Arizona late in the summer of 1921 by Dr. Wyatt W. Jones on the Johnson Ranch, 3½ miles west of Douglas near the international boundary. This variant of *Epilachna borealis* Fab. probably migrated from the north end of the Sierra Madre Occidental Mountains in Mexico, a distance of 30 to 50 miles south and southeast of Douglas, where the elevation is over 6,000 feet as compared to 3,930 feet at Douglas. It is apparently a Mexican form previously known to inhabit north central Mexico, as no available records report its occurrence on either the east or west coast of Mexico.

This pest probably entered Arizona during the fall flight of 1920 or in the spring of 1921, crossing the Mexican border between Mule Mountain and Whitewater Draw, Ariz., or was introduced with a small supply of vegetables brought into the immediate vicinity of the Johnson Ranch.

Distribution and Spread

The known distribution late in the summer of 1921 was a lone colony, confined to a truck garden on the Johnson Ranch and from here the beetle extended its range at a very slow rate northwestward up the Whitewater Draw, and in September, 1924, the infestation extended only 13 miles beyond the point known to be infested in 1921. In the fall of 1924 it was found in eleven gardens in the Sulphur Spring Valley distributed over an area of about 65 square miles. This infested area covered a strip about five miles wide, and extended from the international border northwestward up the Whitewater Draw for a distance of about 15 miles. An examination of the meteorological records for Douglas, Arizona, showed that during the active seasons from 1921 to 1925 the prevailing winds are from the south or southeast and this would indicate that the direction of spread of the beetles was influenced by the air currents.

Coloration Variations Between the Eastern and Arizona Beetles

The Arizona beetle differs from the northern or eastern form in not having spots on the prothorax,[2] resembling in this respect *E. corrupta*

[1]Jones, Wyatt W., 1924. Squash Pest. Jour. Econ. Ent., Vol. 17, p. 176.

[2]Chittenden, F. H., 1924. Note on the Squash Beetle. Jour. Econ. Ent., Vol. 17, p. 417–418.

Muls. The markings on the elytra are smaller and more uniform in size and shape than in the eastern form, the first two rows of spots closely resembling those in *E. corrupta*. The eastern form is slightly larger and is brighter yellow in color.

Food Plants

The adult beetle was found feeding on the following plants: cucumber, pumpkin, squash, banana melon, and cantaloupe (*Cucumis melo* L.), wild muskmelon or melon loco (*Apodanthera undulata* A. Gray), and both cultivated and wild watermelon (*Citrullus vulgaris* Schrad.). No beetles were ever observed feeding on wild gourds (*Cucurbita foetisissima* H. B. K.), although this plant occurs generally over the valley.

The heaviest infestation was noted on squash and cantaloupe in the order named, and these appeared to be the preferred host plants.

Character and Extent of Injury

Both the adults and larvae normally attacked the plant by feeding on the leaves, where they skeletonized a small area usually near the margin, but occasionally the injured portion was well inside the border of the leaf. Under conditions of heavy infestation or where the feeding was concentrated, the whole leaf was skeletonized. The beetles sometimes marked out circular areas of the leaf by cutting short dash-like incisions almost through the tissue and fed within this area. Circular areas were found on both sides of the leaves. The tissue within the injured portions soon dries and drops from the leaf, leaving irregular ragged holes in the foliage. Where complete skeletonization of the leaf occurs only the larger veins remain. The beetles fed on the upper side of the leaves as well as on the lower, especially where the leaves were slightly rolled or shaded. They were observed to attack the blossoms of squash and cantaloupe and also cantaloupe fruit. The attack was usually concentrated around the crown of the plant and the leaves were injured for a radius of three or four feet from the center.

Seasonal Life History

Field observations[3] in 1924 indicated that the squash beetle is one-brooded in the Sulphur Spring Valley, Arizona, as the overwintered beetles did not appear in the fields until after July 1. Larvae were commonly observed during the first week in August. The first pupae were noted on August 18; and at this time very few overwintered

[3]By Dr. W. W. Jones and Mr. H. Letcher, C. & A. and C. Q. Smelters.

beetles were observed, but third and fourth instar larvae were very numerous. Newly emerged beetles appeared from August 26 until after September 18. Adult beetles were numerous on this date, but only two pupae and one larva were found; no eggs were observed at this season of the year.

Disappearance

A survey of the area infested in 1924 was made by the writer in mid-August, 1925, and he was unable to find the insect. Later scouting[4] in August and September confirmed the findings of the earlier survey. The disappearance of the beetle four years after its introduction into Arizona cannot be explained from data at hand unless by the meteorological variations below mentioned. The number of beetles and infestations had gradually increased up to the fall of 1924. During the season of 1925 the food plants were as prevalent as in previous seasons, the production of cucurbits being the chief trucking industry in the Valley. Irrigation is practiced in the production of such crops and therefore the growers are independent of rainfall. Wild cucurbits and those escaped from cultivation were very abundant in the Valley, especially along the arroyos, at the time the surveys were made.

From a study of the meteorological records representing the infested area, it is found that the minimum temperature during the hibernation period had been lower on two preceding occasions than that recorded during the winter of 1924–25.

Table 1.—Precipitation and Mean Temperature with Departures from Normal at Douglas, Arizona, from September, 1924, to June, 1925, Inclusive.

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Prec.	.69	.04	.01	.19	.03	.03	.12	.02	.24	2.85
Departure from normal	—.50	—.99	—.87	—.67	—.95	—.85	—.55	—.26	—.02	+2.50
M. Temp. (F.)	75.6	63.7	54.4	44.0	41.4	52.0	56.8	62.8	70.6	76.3
Departure from normal	+1.8	—.2	+1.5	—1.4	—4.6	+2.3	+1.9	+2.3	+3.0	—1.0

From September 2, 1924, to June 15, 1925, inclusive, the precipitation was .87 inch for 289 days, with six of the ten months showing an increase in the mean temperature but with January showing a deficiency of 4.6 degrees F., as compared to 3.7 degrees F. for the same month in 1924.

The deficiency in precipitation with an increase in the mean temperature (Table 1) during the hibernation period may have been a contributing factor in the disappearance of the insect.

[4]Scouting by Mr. Houston Letcher.

THE CONCENTRATION OF WIREWORMS BY BAITS BEFORE SOIL FUMIGATION WITH CALCIUM CYANIDE

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ABSTRACT

Applications of 200 to 300 pounds of granular calcium cyanide to the acre with a grain drill under certain conditions will kill a high percentage of the wireworms in the soil, but ordinarily this treatment is too expensive for commercial use. Therefore, advantage was taken of the fact that wireworms will collect in rows or hills of seeds, and several kinds of seeds were planted as baits to concentrate the wireworms in rows. By this method a fairly heavy dosage can be applied to the baited rows, and the amount required to the acre will be considerably less than in broadcast treatment. Beans, peas, and corn all proved satisfactory attractants and concentrated a large percentage of the wireworms in the rows. The effectiveness of the baits was reduced if other foods, such as the remains of an old crop, were left in the field. Experiments showed that the most satisfactory amount of calcium cyanide, considering both the lethal effect and the cost, was 5 to 5.5 pounds per 1,000 feet of row. For baited rows 2½ feet apart this will amount to a little less than 100 pounds per acre, and for rows of greater or less width, the quantity will be decreased or increased accordingly. The percentage of wireworms attracted to the baits decreased as the width of the rows increased, being 96 per cent for 2-foot rows and 80 per cent for 4-foot rows. Commerial applications by several growers gave satisfactory results.

In a preliminary report on the use of calcium cyanide as a soil fumigant for wireworms,[2] it was shown that this material is decidedly toxic to these insects. Three hundred and fifty pounds or more per acre applied with a grain drill killed 100 per cent of the worms, while 180 to 200 pounds per acre killed, on an average, 73 per cent, and under favorable conditions as high as 100 per cent.

At the time this report was made, some of the experiments at Toppenish, Wash., were still in progress. In one series an attempt was made to find out the effect of handling the soil, both prior to and subsequent to the cyanide application. Certain plots were plowed 7 inches deep and then treated with different amounts of cyanide. Some of the plots were gone over with a culti-packer immediately after the cyanide was applied, and others were left undisturbed after the treatment. Still other plots were double disked 4 inches deep and given the same applications and treatments as the plowed plots. The results are shown in Table 1.

The results of the experiments reported in Table 1, in so far as the percentage of wireworms killed was concerned, were unsatisfactory. This may be attributed largely to the fact that the experiments were

[1]Mr. John N. Stone assisted the writer in the field work reported herein.

[2]Preliminary report on the use of calcium cyanide as a soil fumigant for wireworms. Jour. Econ. Ent. Vol. 17, Oct. 1924, pp. 562–567.

TABLE 1.—COMPARISON OF THE RESULTS OF CALCIUM CYANIDE APPLICATIONS ON PLOTS PLOWED AND DISKED PRIOR TO TREATMENT AND PLOTS PACKED AND LEFT UNPACKED AFTER TREATMENT. MATERIAL APPLIED WITH A GRAIN DRILL TO A DEPTH OF ABOUT 4 INCHES

Plot No.	Treatment of land before application	Treatment of land after application	Calcium cyanide, pounds per acre	Total number worms counted in plot	Worms dead, per cent	Number potatoes in ten hills	Potatoes damaged, per cent	Potatoes damaged in checks, per cent	Increase by treatment, per cent per acre	Value of increase over cost of material per acre[1]
3	plowed 7″	packed	176	22	77.3	68	16.17	25.8	9.63	—$19.76
15	plowed 7″	not packed	176	26	73.1	44	17.39	34.8	17.41	—9.09
9	dbl. disked 4″	packed	174	29	48.3	59	7.02	21.2	14.18	—12.53
21	dbl. disked 4″	not packed	170	28	39.3	47	29.78	34.8	5.02	—25.50
1	plowed 7″		238	18	83.3	48	10.40	24.1	13.7	—37.05
13	plowed 7″	not packed	238	21	71.4	74	10.50	29.1	18.6	—19.70
7	dbl. disked 4″		238	36	47.2	56	19.60	24.1	4.5	—41.60
19	dbl. disked 4″	not packed	236	23	39.1	49	18.37	29.1	10.73	—30.11
5	plowed 7″		287	20	70.0	63	7.93	22.3	14.37	—36.85
17	plowed 7″	not packed	287	18	77.7	59	7.27	38.5	31.23	—9.96
11	dbl. disked 4″		284	35	45.7	46	1.81	22.3	20.4	—26.80
23	dbl. disked 4″	not packed	281	36	44.4	58	31.00	40.3	9.3	—42.35

[1]Based on an average field production of 200 sacks of 100 pounds each to the acre and selling for $0.75 per sack. Calcium cyanide at 20 cents per pound.

Owing to the variation in the costs of baits, this item is not included in the data given in Table 1 or in subsequent tables. The cost of baiting, including the bait and its application, would vary from 80 cents to $4.25 per acre, depending largely upon the type of bait used. The cost of planting the baits ranged from 50 to 75 cents per acre. In the experiments reported here, from 50 to 75 pounds of bait per acre were used in rows planted 2½ feet apart. This is approximately the same amount as seed used in planting the crop. Refuse or split beans, corn, kafir, beans, or field peas may be used for baits. The price of these materials ranges from 1 to 5 cents per pound. For baits it is not necessary to use high priced seed, but low priced materials such as would do for feed, are satisfactory.

made in June when the wireworms were beginning to go deeper into the soil, and so were not reached by the cyanide as applied with a grain drill to a depth of 4 inches. A large majority of the live wireworms were below the cyanide.

The experiments show, however, that the plots plowed 7 inches deep just prior to the cyanide application all produced better results than those double-disked 4 inches deep. The plowing, going 3 inches deeper than the disking, turned up more worms, which remained in the moist soil near the surface and were exposed to the cyanide fumes. Also, with one exception, the plots which were packed immediately after the cyanide applications showed better results than those which were not packed, although the difference was not great.

In each plot 10 hills of potatoes were dug at harvest time, and the number of potatoes damaged by wireworm feeding or "stings" counted and compared with a check on two sides of each plot. The percentage of wireworms killed was low, ranging from a minimum of 39.12 to a maximum of 83, which was not sufficient to show much benefit from the treatment. The percentage of undamaged potatoes in the plots varied from 4.5 to 30.8 more than in the check, but in no case did the value of the increase equal the cost of treatment.

Results of these experiments compared with those of others indicate that the disk grain drill did not apply the cyanide to a depth great enough to reach the majority of the worms. Another factor which affected the efficiency of cyanide was the temperature of the soil, which on rising, accompanied by loss of moisture, caused the worms to go deeper into the soil.

These experiments as well as previous ones demonstrate that an application of calcium cyanide to the soil will kill wireworms, but owing to the large amounts required when it is sown broadcast in fields, the expense involved is too great for its general use. If the treatment of wireworms with calcium cyanide is to prove practicable, a means of reducing the amount to be used must be discovered.

It is a well-known fact that wireworms will collect in rows or hills of seed crops. It was believed that advantage could be taken of this habit in control by soil fumigation, to concentrate them in restricted areas through the use of baits, and then treat these areas with calcium cyanide. By this method less material per acre would be required than when the calcium cyanide is sown broadcast. Accordingly, a series of experiments was conducted in which corn, peas, and Kentucky Wonder beans were used for baits. A heavily infested field which had previously

been planted to beets was selected. It ultimately proved that this was an unfortunate selection, for it was observed that the beets left in the field acted as counter-baits and reduced the efficiency of the planted baits. In the initial experiments the baits were planted in rows 6 feet apart, but subsequent experiments showed that a lesser distance would have increased their effectiveness. The efficiency of the baits is shown in Table 2:

TABLE 2.—EFFECTIVENESS OF DIFFERENT BAITS PLANTED IN ROWS 6 FEET APART, USED TO ATTRACT WIREWORMS PRIOR TO TREATMENT WITH CALCIUM CYANIDE

Bait used	Per cent of effectiveness[1]	Number of experiments	Number of worms counted
Beans	88	4	183
Peas	74	7	260
Corn	67	7	335

[1]The figures in this column were arrived at by comparing the number of worms per square foot in the rows and the number per square foot between the rows.

The baits were planted on May 27 and treated with various amounts of calcium cyanide on June 28. A hand drill which placed the material about 3 inches deep was used both for planting and applying the seed bait and calcium cyanide. Wireworm counts were made on July 1, and on October 2 ten hills of potatoes were dug in each plot and check plot.

Table 3 shows the results of applications of various quantities of calcium cyanide, after the worms had been attracted to baits, giving the number and percentage of worms killed, the effectiveness of the baits, the percentage of injured potatoes in the plots as compared with those in the checks, and the gain or loss as compared with the cost of the cyanide.

That the hand drill did not place the baits and cyanide deep enough was indicated by the fact that practically all of the live worms in the rows were below the cyanide. An inch or two deeper would have greatly increased the kill, since the worms are mostly from 4 to 6 inches deep at this time of year. The increase in uninjured potatoes over the check plots varied from 2.7 per cent for the lightest application to 35.8 per cent for the heaviest, and averaged 18.4 per cent for all the plots.

Considering the low efficiency of the baits, caused by the presence of the refuse beets in the field, the increase in undamaged potatoes is considered quite satisfactory, four of the plots showing good profits even under the adverse conditions of the experiment.

EXPERIMENTS IN SOUTHERN CALIFORNIA IN 1925

Encouraged by the results obtained in the State of Washington in 1924, further experiments of a similar nature were made in southern

TABLE 3.—EFFECTIVENESS OF BAITS USED, EFFECTIVENESS OF THE DIFFERENT STRENGTHS OF CALCIUM CYANIDE, INCREASE IN NUMBER OF UNINJURED POTATOES, AND THEIR VALUE IN RELATION TO THE COST OF THE CYANIDE TREATMENT. ROWS 6 FT. APART, APPLICATION MADE WITH A HAND DRILL 3 INCHES DEEP

Plot No.	Lbs. per acre	Effectiveness of bait, per cent	Wireworms: Total number	Wireworms: Killed in row, per cent	Wireworms: Total killed, per cent	Potatoes: Number dug in 10 hills	Potatoes: Per cent uninjured	Potatoes: Per cent uninjured in check[1]	Potatoes: Increase by treatment, per cent	Value of treatment per acre compared with cost of material[2]
H-7	27	91.3	57	85.4	82.0	43	72.0	69.3	2.7	—$1.55
H-1	47	61.0	55	87.7	78.7	46	65.3	61.8	3.5	—3.75
H-2	77	65.6	106	91.6	83.0	51	84.0	61.9	22.1	+17.75
H-4	95	84.6	192	94.0	90.6	57	52.6	34.7	17.9	+7.85
H-3	118	75.3	196	93.4	87.2	58	69.0	37.3	31.7	+23.95
H-6	147	64.0	71	88.5	76.0	70	80.0	65.1	14.9	—7.05
H-5	165	85.0	97	95.6	92.0	44	75.0	39.2	35.8	+20.70

[1]Checks and plots alternated in this experiment. Each plot is compared to the average of the two checks adjoining.

[2]Based on an average production of 200 sacks of 100 pounds each per acre at $0.75 per sack, and calcium cyanide at $0.20 per pound.

TABLE 4.—COMPARATIVE EFFICIENCY OF DIFFERENT BAITS FOR WIREWORMS, AND ALSO THE EFFICIENCY OF THESE BAITS WHEN PLANTED IN ROWS OF DIFFERENT WIDTHS

Bait	Number of wireworms per sq. ft. in rows of following widths[1]				Number of wireworms per sq. ft. between rows of following widths				Per cent[2] of wireworms in rows of following widths				Total number of wireworms counted in rows of following widths				Total number of sq. ft. from which counts were made, widths of rows			
	2′	2.5′	4′	5′	2′	2.5′	4′	5′	2′	2.5′	4′	5′	2′	2.5′	4′	5′	2′	2.5′	4′	5′
Lima beans[3]	0.70	1.5	2.6	3.2	0.00	0.06	0.09	0.07	100.0	86.2	80.5	83.5	26	92	119	128	66	96	90	100
Corn	0.60	2.5	1.7	2.8	0.0	0.05	.13	0.20	100.0	92.6	65.1	60.9	12	60	27	30	40	40	30	20
Peas	0.60	1.9	1.9		0.02	0.0	0.05		90.9	100.0	84.4		25	74	29		80	80	32	
Misc. Mix.		1.9		3.2		0.05		0.20		90.5		64.0		180		33		154		10
Average	0.63	1.9	2.1	3.1	0.01	0.04	0.09	0.16	95.4	91.8	77.7	68.3					186	370	152	130

[1]In the row the square foot was an area 6″ x 24.″

[2]Since the unit area was 24 inches in length and 6 inches in width, the area between rows was taken from center to center of the area between rows and 24 inches long. These percentages then were based on the calculated number of wireworms in this area.

[3]In these experiments both whole beans and "splits" were used.

California in 1925, where conditions were somewhat different. Beans, corn, peas, and a miscellaneous mixture were used as baits and planted in rows 2, 2.5, 4, and 5 feet apart. This work was all done on land which had been kept free of plant growth during the winter. The experiments were begun in April soon after the worms became active. The effectiveness of the baits is shown in Table 4.

There appeared to be little difference in the attractiveness of the several baits used, but the experiments indicate that as the distance between the rows increases the percentage of wireworms attracted to the baits decreases.

Since crops are planted in rows of different widths, the rate of application per acre will necessarily be considered with regard to the width of the row. The following table gives the variation in the rate per acre of various amounts per 1,000 feet of row, for rows of different widths.

TABLE 5.—RATE PER ACRE FOR CERTAIN AMOUNTS OF CALCIUM CYANIDE PER 1,000 LINEAR FEET OF ROW, FOR ROWS OF DIFFERENT WIDTHS.

Lbs. per 1,000 ft. of row	Distance apart of rows				
	2′	2.5′	3′	4′	5′
	Pounds per acre				
4.5	98.2	78.6	65.4	49.1	39.3
4.8	104.8	83.8	69.8	52.4	41.9
5.0	109.2	87.3	72.7	54.6	43.6
5.5	120.1	96.0	80.0	60.0	58.0
6.0	131.0	104.8	87.2	65.5	52.4
6.3	137.5	110.0	92.6	68.7	55.0
7.0	152.8	122.3	101.8	76.4	61.1
7.7	168.1	134.5	112.0	84.0	67.2

A number of experiments were made early in the season of 1925 to determine both the attractiveness of the bait and the effect of the cyanide. Results of the tests have been included in Table 6, which shows the results of different strengths of cyanide applied in rows where trap crops had previously been planted.

TABLE 6.—EFFECTIVENESS OF DIFFERENT AMOUNTS OF CALCIUM CYANIDE APPLIED IN ROWS OF DIFFERENT WIDTHS AFTER THE WIREWORMS HAD BEEN CONCENTRATED BY BAITS

Lbs. per 1,000 ft. of row	Per cent of worms killed			No. of experiments	Number worms counted to get per cent of kill
	Max.	Min.	Avg.		
4.5	100	60	83.99	14	235
4.8	90	80	86.5	9	203
5.25	100	87.5	90.8	5	66
5.5	100	70	90.8	24	434
6.3	96.43	95.23	95.8	2	70
7.7	100	100	100.0	1	28

The data obtained indicate that as the dosage increases the mortality increases. It also indicates that an average kill of practically 91 per cent was obtained by using from 5.25 to 5.5 pounds per 1,000 feet of row. By reference to Table 5 it appears that this rate is approximately 90 to 100 pounds per acre for 2.5 ft. rows. This amount is suggested as the best for general purposes. The cost is about $20.00 per acre for rows 2.5 feet apart, and less or more according as rows of less or greater width are used.

On hearing of the results obtained in these experiments, several bean growers decided to make commercial treatments of an acre or more on their infested lands. In some fields split beans were drilled in for baits, while in others the lima beans which had been planted for a crop became so badly infested that these were treated. The cyanide was drilled in with the Ventura type 4-row bean planter, all rows being 2½ feet apart. All of the work was done by the growers themselves, under general directions. From 10 to 20 feet of row were examined in several parts of each field, and the number of dead and live worms counted. In most fields examinations made between the rows showed the baits about 90 per cent effective, and in several fields practically 100 per cent effective. In tests where two applications of 45 and 70 pounds of cyanide per acre were made, an average kill of 50 per cent resulted. Where 7 applications of from 90 to 110 pounds per acre were made, the kill varied from 79 to 100 per cent, while one application at 145 pounds per acre resulted in a kill of 100 per cent.

In all of the experiments reported in this paper, granular calcium cyanide was used. This is a crude cyanide ground to the fineness of coarse coffee, and with a cyanide content equivalent to from 40 to 50 per cent of sodium cyanide. Laboratory and field experiments were performed with a dust form of calcium cyanide, which had a sodium cyanide equivalent of from 25 to 35 per cent. This gave poorer results, and, moreover, in the fine dust form, was both more unpleasant and difficult to handle than the granular form.

Alfalfa Weevil Parasite, *Bathyplectes curculionis* Thoms. A correction: In the April 1926 issue of the JOURNAL OF ECONOMIC ENTOMOLOGY (Vol. 19, No. 2) on page 303, line 10 the sentence "In most of the regions studied adults issue from these cocoons in about two weeks and oviposit in weevil larvae of the second generation" should read "In most of the regions studied the adults issue from these cocoons in about two weeks and oviposit in other weevil larvae."

T. R. CHAMBERLIN, *U. S. Bureau of Entomology*

COMPARATIVE TESTS WITH SODIUM FLUOSILICATE AND CALCIUM ARSENATE FOR THE CONTROL OF THE COTTON BOLL WEEVIL (*ANTHONOMUS GRANDIS*)

By M. R. OSBURN, *Ohio State University, Columbus, O.*

The experiments outlined here were carried on at the Upper Coastal Plain Experiment Station, Rocky Mount, North Carolina. They were suggested by Mr. Bruce Mabee, Extension Entomologist of North Carolina.

Calcium Arsenate Dust is recommended by The United States Department of Agriculture for the control of Cotton Boll Weevil, but as Sodium Fluosilicate has been found satisfactory in some other cases, (Marcovitch 1924)[1] it was thought advisable to compare its efficiency with that of the standard control method.

Field plots consisted of twenty rows of cotton two hundred yards in length. One plot was treated with sodium fluosilicate, the next left as a check, the next treated with calcium arsenate. The arsenate was applied at the rate of five pounds to the acre and the sodium fluosilicate, being heavier, at ten pounds to the acre. Following the usual field practice, dusting was not carried on until an infestation of ten per cent of squares was reached.

Cage tests were also made to determine the comparative toxicity under close observation and with definite numbers of weevils, which were reared for the purpose.

The work extended over a period of three months, the field and cage tests being made during the period of greatest activity of the weevils. Power dusting was used in field tests and hand dusting in cage tests, care being used to insure approximately the same amount and distribution of dust in all cases. The dust in field tests was applied in most cases early in the morning between the hours of four and six. The time of dusting in the cage tests was purposely varied, but was without significant variation in the results. Three applications of dust were made at four day intervals, following the usual practice.

Sodium fluosilicate appears to act as a repellent as well as an insecticide, as weevils tended to collect on the side of the cage after dusting. Actual feeding is not necessary to produce killing. If the insect gets any of the sodium fluosilicate on its feet, it appears to cause an irritation which results in the weevil bringing the feet in contact with the mouthparts. Weevils placed on cotton leaves dusted with sodium fluosilicate and on which they did not feed nevertheless died in a few hours.

[1]S. Marcovitch, Tennessee Station Bulletin 131, 1924.

Field Tests

In two series of field tests the average per cent of infestation after treatment is shown in the following table.

	Sodium fluosilicate Infestation	Check Infestation	Calcium arsenate Infestation
	11.25% (dusted)	13.75%	(dusted) 12.75%
Four days later.....	4.75%	28.75%	11.25%
Four days later.....	7.00%	27.50%	7.25%
Three days later.....	3.50%	45.50%	7.00%

Cage Tests

In four series of cage tests the average per cent of dead weevils after treatment is shown in the following table.

	Sodium fluosilicate	Check	Calcium arsenate
Dead weevils after 6 hrs.	40%	6.0%	18%
After 24 hrs.	80%	7.5%	45%
After 48 hrs.	87%	7.5%	69%

Under the conditions of these experiments sodium fluosilicate was more effective against Cotton Boll Weevil than calcium arsenate, and reached its effectiveness in less than half the time.

An average control of eighty per cent was attained in twenty-four hours, while forty-eight hours were necessary for a control of sixty-nine per cent with calcium arsenate.

Rate of kill is an important factor in rainy weather. Maximum effect of sodium fluosilicate is reached within twenty-four hours and rain after that time would not necessitate redusting at once.

There was some evidence of burning on the more tender foliage, but this was so slight as to be of no importance, therefore no attempt was made to dilute the sodium fluosilicate.

A BRIEF HISTORY OF THE STICKTIGHT FLEA AND THE FOWL TICK IN THE UNITED STATES

By D. C. Parman, *U. S. Bureau of Entomology*

Abstract

The probable origin and spread of the sticktight flea, *Echidnophaga gallinacae* and the fowl tick, *Argas miniatus* are set forth. A list of host animals for each species is given together with the most important biological data relating to each. A discussion of the economic importance of the two pests is included.

The purpose of this article is to bring to the attention of entomologists and others interested a brief summary of the history of the sticktight flea, *Echidnophaga gallinacae*, and the fowl tick *Argas miniatus*, in

order that the destructiveness of these two pests may be more generally realized and the necessity for concerted and immediate action may be understood. The material in this paper was gathered from available literature on the flea and tick, from notes made in the study of these parasites in the laboratory, and from personal observations on a small commercial flock of chickens at Uvalde, Texas.

In order that the value of the poultry industry as compared with other leading industries may better be understood, the following figures compiled by the federal government are submitted:[1]

"Estimated value of some of the leading agricultural crops (1920)": "Poultry products, $1,047,000,000 (this is the value of poultry products on farms only and does not include the value of hundreds of thousands of small flocks); cattle raised, $924,000,000; wheat, $726,000,000; all fruits and fruit products, $681,000,000; oats, $539,000,000; potatoes, $340,000,000; tobacco, $299,000,000."

More people in the United States are directly interested in raising poultry than any other food, and poultry products are among the most universally used foods of the American table.

Besides poultry, the flea attacks English sparrows, owls, cats, rats, rabbits, goats, dogs, mules, horses, and human beings. The wild hosts of the flea are not well known but there is reason to believe that it will feed and develop on most warm blooded animals. The hosts of the tick are, so far as known, relatively few, and its attacks are closely confined to poultry. However, there are records of its having been collected from meadow lark, wild turkey, jack rabbit, cattle, and man. It has also been induced to feed on rats and mice experimentally.

Origin and Spread

The origin of the domestic hen, the sticktight flea, and the fowl tick is, in all probability, southern Asia. Oken briefly described the fowl tick from Persia in 1818; Koch described what is unquestionably the fowl tick that we have in America from British Guiana in 1844. These facts leave some doubt as to the Asiatic origin of the tick. The flea was first collected by a member of the Challenger Expedition in Ceylon in 1874 or 1875, and was described by Westwood.

Since the discovery of the flea and tick they have gradually spread until at present they are formidable parasites of poultry throughout the tropical and subtropical parts of the world. It is worthy of note that the adaptation and spread of the domestic hen as food for man has

[1]United States Department of Agriculture Yearbook, 1924, 1252 p., illus. Washington, D. C.

closely paralleled the spread of these parasites. It is true that the hen has been successfully acclimated outside of the tropical and subtropical regions faster than the parasites have for the reason that she has had the assistance of man by selection and protection.

The flea was first discovered in the United States in 1886 in Florida and in 1892 was reported in Texas. The tick was first collected in 1872 in the southwestern part of Texas. The dispersion of the tick in the United States has been rather gradual and orderly. The spread of the flea has been sporadic, but the infestations are rather general and continuous in the Southwest at present. The tick has been reported from as far north as Iowa and the flea from Minnesota, but it is doubtful whether infestations of either are established so far north. The present distribution of neither is known with any degree of accuracy, but there are established infestations of the ticks from Florida to California and as far north as Oklahoma. The established flea infestations extend from South Carolina to California and as far north as Kansas and Missouri.

Both of the parasites have been most destructive in their attacks on poultry and other hosts in the southwestern states, and appear to prefer a warm, semiarid climate. The adult flea spends most of its life on its hosts. The immature stages are found in the sleeping or resting quarters of the hosts, and these stages are very susceptible to climatic changes, moisture, and heat. The tick in all its stages is found hiding in cracks and other protected places in the sleeping quarters of its hosts. All stages will stand a wide range of temperature and moisture conditions.

The flea lays most of its eggs while attached to the host and these fall to the floor of the host's sleeping quarters. The young apparently require the adult excreta for food. So far as is known, the immature stages will develop or die within a period of two or three months. An infestation of flea larvae and pupae were kept 132 days during the winter without adult food, and a few adults were alive, but weak, on the last day examined. Six months would probably be the maximum period that a flea infestation would persist without a host. All stages of the tick, except the unfed larvae, will persist for long periods without hosts. Eggs have been kept viable for five months and the adults have been kept without food for more than two years.

Under the most favorable conditions the flea will develop from egg to adult in from two to three weeks; the minimum period for the development of the tick is about six weeks.

The maximum period of attachment to the host is forty days for the flea and ten days for the tick. The flea usually remains attached to the host for about two weeks. The larval stage of the tick remains attached usually for four days, the other stages for only a few hours, generally at night.

The flea prefers young hosts but readily attacks those of all ages; the tick does not appear to show any preference.

Economic Aspects

From the very first reports of the flea and tick in the United States they have been considered serious pests, and as they have spread over the world the same opinion has prevailed wherever they have become established. It is rather remarkable that these foreign pests with such destructive propensities should have been established for so long a time and should continue to gain ground without having received more than passing attention from entomologists and others concerned.

As has been stated, the occurrence of the flea is rather sporadic, but in the heaviest infestations observed it is most destructive to poultry. Entire flocks of chickens have been destroyed within a few weeks where large flocks used closely built houses or roosted or rested under large buildings. In the southwestern part of Texas there is each year a loss of poultry caused by the flea, but the past season has in this respect surpassed any on record. Ordinarily the losses from the tick are less sporadic and violent than from the flea, but they are so continuous and so heavy that many people will not attempt to grow chickens after the tick has become established.

At present the flea is not known to be associated in the transmission of any disease, with the possible exception of plague. The tick, however, is known to be responsible for the transmission of the disease so fatal to fowls, spirochetosis. The presence of spirochetosis in the United States has not been definitely established but it is likely to be introduced at any time, and even now it may be present, for there are some grounds for believing that cases have occurred in the southern part of Texas in the last few years.

Poultry can now be profitably produced even in the area of heaviest infestation where proper control measures are applied, but if the two parasites should become established and acclimated over a much greater territory, and the present methods of handling fowls should continue, there is little doubt that chickens would be exterminated on most of the farms in the United States.

Conclusions

It is believed that the sticktight flea and the fowl tick are potentially two of the most important of our imported pests. Even now the loss which they annually occasion runs into hundreds of thousands and probably millions of dollars. They possess the possibility of directly affecting more people than any other known pests. The control of these parasites is, therefore, a problem of national concern, and the combined efforts of state and federal entomologists should be directed to its solution.

SURVIVAL EXPECTANCIES OF TWO APHIDS

By A. C. Baker, *Bureau of Entomology, United States Department of Agriculture*

Two subjects to which Entomologists seem to have given little attention are (1) the relative ages of individuals in an insect population and (2) survival expectancies in species. It is obvious in this connection that a knowledge of individual ages would be of value. In the malarial problem, for example, a knowledge of the age of individual mosquitoes could be used to advantage; and in cases like that of the beet leafhopper, where extent of migration is a factor, age determination could be utilized. In spite of the value of such a knowledge, however, we are unable at present to determine the ages of individuals except in a general way by distinguishing newly emerged from "worn" specimens.

The value of a knowledge of survival, apart from its general biological interest, is not so strikingly apparent. The graph presented (Fig. 38) was prepared with the following possibility in mind: Two types of aphids are well known. Species of the first type are always with us in fair abundance. Those of the second are very irregular in their numbers and produce epidemics under favorable circumstances. It occurred to the writer that the aphids of these two types might show some difference in expectancy of life. The curves presented are the ordinary survival curves of the actuary, where individual life spans are plotted against the species life span, represented here by the longest life in the population studied.

Two common species were chosen, *Aphis pomi* De Geer, the well known green aphid of the apple, and *Toxoptera graminum* Rond., the "green bug" of the grain fields. This latter species produces epidemics, often of considerable magnitude. It was the original intention to plot the lives of a thousand individuals of each species but a dearth of records prevented this. The data for the green bug were taken from published

papers and from the files of the Bureau of Entomology. For these latter I am indebted to W. R. Walton. The records for *Aphis pomi* are

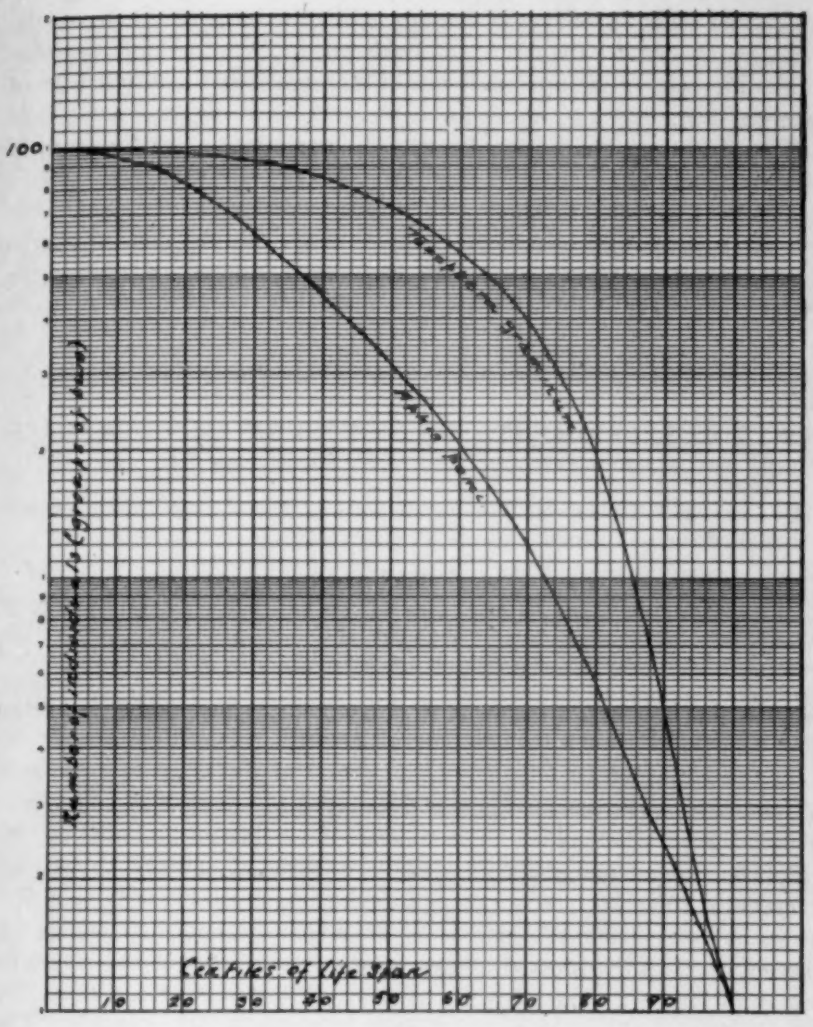

Fig. 38.—Graph showing survival expectancies of two aphids.

from the rearings made by W. F. Turner and the writer at Vienna, Va. With both species, late, partially hibernating, and all egg-laying forms were discarded, since these individuals are not concerned in the

rise or fall of the species after the initial population of viviparous forms in the spring has been reached.

It will be noted from the curves that the expectancy of Toxoptera, the species which produces epidemics is, on the basis of these records, considerably greater than that of *Aphis pomi*. Whether this is a constant difference in the species it would be hazardous to state in view of the meager number of records available. If, however, it is a constant difference it may have some bearing on the relative ability of these species to increase.

This brief note is published not so much to present a conclusion as to indicate a possibility and incidentally to point out the dearth of anything like adequate quantitive life records of insects. Wherever the writer has turned he has met the same difficulty.

CONTROL EXPERIMENTS ON THE SURINAM COCKROACH (*PYCNOSCELUS SURINAMENSIS* L.)

By CHARLES F. DOUCETTE, *Bureau of Entomology, United States Department of Agriculture*, and FLOYD F. SMITH, *Pennsylvania Bureau of Plant Industry*

ABSTRACT

Pycnoscelus surinamensis L., a tropical cockroach, has been found doing injury in a number of greenhouses in the eastern part of the United States. A study of its habits has been made and experiments conducted to determine practical control measures adaptable in commercial greenhouses. Tests with poisoned baits indicate that their use over large areas would be impractical. Sodium cyanide in solution when applied to the soil is the most promising control material used.

In the spring of 1925 a heavy infestation of the surinam cockroach (*Pycnoscelus surinamensis* L.) was discovered in a large range of greenhouses near Philadelphia. The roaches were present literally by the millions, and an inspection of the greenhouses after dark showed an average of 25 to 30 insects per plant crawling around on the beds and walks. About 30,000 to 35,000 rose plants from a total of 200,000 in the three more heavily infested houses were so badly injured by the gnawing off of the bark, young buds, and shoots of the main stems, that they were not in condition to be kept in the beds for another season. The girdling of the stems weakened the plants and the loss of the buds near the ground prevented the development of growth for a succeeding crop. This plant-feeding habit of the roach is thought to be only secondary since it evidently feeds mostly on decaying organic matter. Although the roaches had been observed in cabinets and trash barrels for about

two years, and the plant injury had been noticed for several months, it was not until the manager had occasion to go through the house one evening that he discovered that roaches were the cause of the troubles previously attributed to fertilizers, soil condition, watering, fungus, and other agencies.

Shortly after this heavy infestation was reported lighter infestations were found in two other greenhouse ranges in the Philadelphia district, the one growing roses exclusively, the other a miscellaneous collection of ornamental plants. A moderate infestation was also reported at another range close to Philadelphia, devoted to the culture of decorative plants, where the roaches were feeding on the young fronds of Cibotium ferns. An infestation is also reported to exist at present in a rose establishment at Rowayton, Conn. (1)[1]

Habits

These cockroaches are negatively phototropic and do not appear in the daytime unless disturbed in their hiding places. Most of them were found hiding in the soil along the edges of the beds, although a considerable number would dig down anywhere in the soil and many concealed themselves in the loose cinders of the walks. At the end of one house thousands of the pests took up their abode in and under a cabinet where the workmen kept rubber boots and tools. Removal of boxes and trash barrels near this wall would invariably reveal large numbers of the roaches scattering in all directions in search of cover. Bags laid on the ground were favorite hiding places. Because of their decided nocturnal habits an infestation of these insects might exist in a greenhouse for an indefinite period without being discovered.

A very noticeable occurrence was the departure of many of the insects from the beds which were being dried to the more moist soil where the plants were still being forced, and to the outside of the greenhouse where myriads located themselves in a loose cinder "fill" close to the walls of the greenhouse. This migration was apparently due to the hardening of the drying soil rather than to the lack of moisture. At about this time a prolonged period of very high temperature occurred which may also have had some influence in causing the insects to change their location. Several hundred were found in a pile of trash and sweepings about 25 feet from the greenhouse.

According to Zappe (2) the entire life cycle from egg to maturity requires an average of 7½ months. It is of interest to note that in the Pennsylvania infestation, of the several thousand individuals examined

[1]Reference is made by number to "Literature Cited."

no males were found, which fact is in keeping with the findings of Zappe. Only one male has been discovered in North America (3), although males have been found in the Tropics.

Control

Attractants. To test the attractiveness of various substances, materials were placed on bits of cotton waste in pint size milk bottles, and these were buried in the beds so that their tops were even with the ground level. The results of two series of these tests are given in Table 1.

Table 1.—Showing Comparative Attractiveness of Several Materials for the Surinam Roach

Material used	Number of roaches in the bottles after seven days
Series A	
Sugar syrup and borax	268
Sugar syrup and butyric acid	562
Sugar syrup and anise oil	1
Check	36
Series B	
Liquid manure	2
Dry manure	74
Lactic acid	71
Dead roaches	12
Butyric acid	235
Anise oil	4
Rose petals	219
Check	16

Of these materials the sugar syrup, butyric acid, and rose petals and combinations of syrup and butyric acid and borax were most attractive.

Poisoned Baits. To obtain indications on favored foods, various substances were placed on boards and papers laid on the beds early in the evening. Observations lasting for several hours were made to determine whether the roaches would feed and to what extent. Of the several materials used, the most desirable seemed to be a thin paste composed of dextrin and water, in common use in greenhouses for labels. Within a half-hour after a newspaper which had been brushed with some of this material was laid on the bed, 200 roaches were feeding on the paste and two hours later it was entirely consumed. Fresh rose leaves or flowers dropped on the soil were completely eaten in 20 to 30 minutes. Stale cheese also attracted a considerable number of the roaches, but the small quantity used was only half consumed during the night. Agar was eaten slightly, and five to ten roaches were seen around it occasionally, but it did not appear sufficiently attractive to warrant its use as a bait. Agar and sodium arsenite were not touched

and very few roaches were seen to approach it while under observation. Very little feeding occurred on agar containing potassium cyanide, and only 10 to 12 roaches were observed around it at one time.

Zappe (4) reported that a phosphorus paste was readily eaten and was very effective in killing the roaches; and that borax in combination with other materials was also effective. In preliminary tests made with roaches confined in flower pots, phosphorus paste killed all the individuals within 7 days. Similar tests with borax and sugar syrup gave 20% mortality, but a banana paste containing cocoa and borax killed none of the roaches. Although phosphorus paste was readily eaten and indicated excellent killing qualities, its extreme cost would prohibit its use in a commercial greenhouse.

The dextrin paste which had proved so attractive to the roaches was used as a carrier for several supposedly toxic chemicals in a series of tests in which the insects were placed in four-inch flower pots with soil and a small amount of each preparation spread on a small square of paper laid on the soil surface. The dextrin was mixed with each chemical in the respective proportions and then sufficient water was added to give a paste of the desired consistency. For each material three lots containing 2%, 5%, and 10% were made up with the exception of mustard gas and Lewisite. One cc. of each of these latter materials was added to 100-gram lots of dextrin. Comparisons in amount of feeding were made with checks of dextrin paste and the tests were concluded at the end of 11 days. Mustard gas and Lewisite were not eaten; sodium fluoride, sodium fluosilicate, and phenyl arsenious oxide were eaten in moderate amounts; and lead chromate and barium carbonate were eaten in large quantities, but in none of these tests was there any kill. Paris green was lightly eaten and gave 10 to 55% kill. Lead arsenate and calcium phenyl arsenate were eaten in moderate quantities and gave 45 to 80% and 60 to 80% kill respectively. Of the materials readily eaten, borax killed 20 to 80%, calcium arsenate 80 to 100%, and diphenyl arsenious oxide 40 to 100%. The percentage of kill varied with the quantity of the poison in the dextrin in all the tests except those with lead arsenate and diphenyl arsenious oxide, where the highest concentration gave the lowest kill.[2]

SOIL TREATMENTS. Several soil treatments were made in pots and on plants generously placed at the writers' disposal by the greenhouse manager.

[2]The authors wish to thank Mr. Floyd J. Brinley, U. S. D. A., for aiding in their tests and for preparing the following materials: calcium phenyl arsenate, diphenyl arsenious oxide, phenyl arsenious oxide, mustard gas, and Lewisite.

Three hundred cc. of carbon bisulfide emulsion, as recommended for Japanese beetle larvae (5)—that is, diluted 2.5 cc. stock solution to 1000 cc. water—was applied to roaches in both moist and dry soil in flower pots containing approximately 300 grams of soil. The liquid which drained through the pots was poured back several times so that the soil was thoroughly saturated. Three tests were made using ten individuals in each, but no effect was observed on the roaches.

Sodium fluoride and sodium fluosilicate were dusted over the soil surface in pots containing roaches and no mortality occurred in a period of ten days. In two tests ten roaches were placed in a beaker with the powders and became thoroughly dusted by their efforts to bury themselves. They were kept in flower pots for observation but none died as a result of this treatment.

Sodium cyanide in solution and phenol crystals in solution were also used in pot experiments. In these experiments, 1/10 gram of the former or 1 gram of the latter dissolved in 100 cc. of water and applied to about 400 grams of soil in pots containing roaches gave 100% mortality after 24 hours. Five one-hundredths grams of sodium cyanide in similar tests killed immature individuals only. Since these experiments indicated possible control with sodium cyanide and phenol solutions, these were applied at varying strengths on plots of 50 plants each in the greenhouse beds. It was hoped that these trials would show a satisfactory toxicity to the cockroaches at a strength which the plants would tolerate.

Phenol solution applied on plots of rose plants* (five year old Premier) gave the following results:

Grams phenol per plant	Condition of insects in plots five days later	
	Dead	Alive
8.5	9	17
3.7	3	4
1.7	0	6

*No effect on plants was evident after two weeks.

Table 2 is a tabulation of the results obtained with the sodium cyanide solutions.

In these tests no effort was made to prevent the entrance of roaches from adjacent untreated portions of the beds, and no doubt a part of those found alive in the plots came in from untreated plots during the intervening night.

Applications ranging from 2.5 grams to 4 grams per plant were made June 15 in an attempt to find the point at which the roses would be injured. The plants in all the plots were in good healthy condition on

TABLE 2.—NaCN SOLUTION APPLIED ON PLOTS OF 50 PLANTS EACH

Date of treatment 1925	Pints of solution per plant	Grams NaCN per plant	Condition of insects after 24 hours around 10 plants		
			Dead	Alive	Per cent killed
May 22	2	0.5	6	21	22
	1	0.5	21	25	45
	2	1.0	23	6	79
	1	1.0	100	9	91
	2	1.5	85	5	94
	1	1.5	92	7	92
Check	0	0	0	55	0
June 8	1	1.5	15	1	93
	1	1.75	13	0	100
	1	2.0	16	7*	69
	1	2.25	19	0	100
	1	2.5	14	1	93
Check	0	0	0	19	0

*These 7 were found alive in one spot near a post and the material may not have reached them.

June 18 and showed no difference in comparison with the check plots. On June 20 they were dug out and no ill effects could be seen on the roots, thus indicating a wide margin of safety for the use of the sodium cyanide under such conditions. These plants were five-year-old Premier and were not watered after June 1, which is a probable cause of the decrease in proportionate numbers of the roaches in each plot.

EFFECT OF SODIUM CYANIDE ON ROSE PLANTS SIX WEEKS FROM TIME OF PLANTING (VARIETY BUTTERFLY)

Grams NaCN per plant	Condition of plants after one week			
	Dead	Badly injured	Moderately injured	Uninjured
2.0	3	0	13	9*
2.5	10	15	0	0
3.0	22	3	0	0

*Four of these plants showed an occasional bleached leaf. The material was applied at the rate of one pint of the solution per plant.

The results from these treatments show the danger of using the cyanide solution on recently planted roses, the exact reason for which was not determined.

Kerosene was poured along the edges of the beds by the manager of the greenhouses. This was quite effective in killing such roaches as were reached. Within a few seconds after pouring oil along the edge of a bed there would be a sudden exodus of the insects, all running frantically about for a short time until killed by the oil. The oiliness of this treated soil at the edges of the beds repelled the roaches somewhat so that they

were to be found in the soil more toward the center of the beds. In places the oil applications caused yellowing of the leaves of some plants and the killing of others outright. Burlap bags in one house, each bag sheltering several hundred roaches, were occasionally lifted and the insects killed by spraying with kerosene.

Bantam chickens allowed to roam through the greenhouses were apparently fond of the cockroaches but would not scratch deep enough to uncover them, and were therefore of little value in controlling the pest.

After the migration of the roaches to the outside, large numbers were killed by applications of kerosene to the cinders close to the walls. It is of interest that over 500 gallons of kerosene were used during the months of May and June in combating this infestation.

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WATER-CARRIERS VERSUS NECTAR-CARRIERS

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ABSTRACT

Water-carriers may be distinguished from nectar-carriers by gently pressing on the abdomen of the loaded bee while it is held fast on a sheet of filter paper. If the disgorged honey-sac contents is nectar, a translucent spot will be produced on the filter paper; whereas, if it is only water, no such spot will remain upon drying. No suitable chemical test was found. Individuals selected by means of this test showed that nectar-carriers working on white sweet clover required on the average, one-half to three-quarters of an hour to make a round trip, while water-carriers, obtaining their loads within 50 yards of the apiary, completed their round trips in 5 minutes on the average.

Water-carriers cannot be distinguished from nectar-carriers by their appearance because water and nectar are both carried in the honey-sac, which is located inside the abdomen of the bee. Yet, in order to study the activities of individuals engaged in these respective occupations, it became necessary to be able to determine whether a given bee was engaged in carrying water or nectar. One way was to kill the bee, dissect out its honey-sac and taste the contents. This manner of determining the honey-sac contents was used frequently to find out what proportion

of incoming bees was carrying nectar and what proportion was carrying water. But a bee subjected to such a test was not a promising subject from which to determine such things as, for instance, the number of trips a water-carrier would make in a day. Hence, a means for finding the nature of the honey-sac contents without injury to the bee was greatly to be desired.

The Filter Paper Test

It was found that a drop of sugar solution when placed upon filter paper produced a translucent spot somewhat similar to the spot produced by a drop of oil on paper; while water, upon drying, left no such spot. It was found also that a bee could be induced to disgorge a portion of its honey-sac contents. The bee to be tested was caught as it returned from the field, and was held fast on a sheet of filter paper while gentle pressure was applied to its abdomen. That part of its load which it disgorged, fell upon the paper. Less than half of a good load was sufficient for the test. That no appreciable injury was done the bee was attested by the fact that the bees subjected to this test continued to yield data as satisfactorily as pollen-carriers which, of course, did not have to undergo any such test.

Investigation of the limits of this test showed that it was useless for detecting the presence of sugar in aqueous solutions of honey containing less than about 30 per cent sugar. The test is, therefore, less delicate than the average human taste when dealing with quantities of solution sufficient to admit tasting; but when dealing with a fraction of a drop of a solution which contains 30 per cent, or less, of sugar, the human taste is seldom, if ever, to be relied upon. Furthermore, the filter paper test is more convenient, it gives a semi-permanent record, and in many other respects is better adapted to the needs of the case.

The fact that the sugar content of nectar is usually given as about 20 per cent, may lead some to doubt the trustworthiness of this test; but the data obtained from marked bees selected by means of this test, have never indicated, even in a single case, that an error had been introduced through the use of the test. How, then, are these facts to be reconciled?

As a matter of fact, the sugar content of nectar varies widely in different plants and in the same plant under different conditions. But let us assume that it contains 20 per cent. Then if the nectar as delivered at the hive has lost none of its water content en route, the above facts probably could not be reconciled; but if, as many have been led to believe, the bee has some means of eliminating part of the water from

the nectar before arrival at the hive, the grounds for such doubts would be greatly reduced, if not eliminated.

Exact data on this point are exceedingly limited. De Planta (1) found that the sugar content of nectar from four different species of plants ranged from 7 to 40 per cent, with an average of about 20 per cent. While he made no determinations on nectar just as it arrived at the hive, he reported analyses of what he called "new honey" from five samples produced by three species of plants. The sugar content of these ranged between 66 and 79 per cent. De Planta's own interpretation of these data was that he believed that the bees threw off a considerable quantity of the water while the nectar was in their honey-sacs.

In support of this theory, there is the well known circumstantial evidence that, during a heavy honeyflow, incoming bees often spurt out a tiny jet of colorless liquid before entering the hive. A. I. Root (2), while conducting an experiment on wintering bees in a greenhouse, made an observation which is of interest in this connection. The bees had been in the greenhouse three days and were feeding on *thin* syrup from a feeder located at the opposite end of the room, when he noticed laden bees going out of a hive so rapidly that he suspected the colony was being robbed. But he succeeded in following them on the wing and made out to his entire satisfaction that after flying a while in the sunshine, they discharged from their bodies what seemed to be only pure water. After this maneuver, they were seen to return immediately to their hive with bodies so reduced in size that they made quite a contrast with their comrades who were just going out. Root suggested that this might be a part of the natural process of freeing the raw honey of its superfluous water.

Thompson (3) reported similar observations on bees fed very thin syrup either inside the hive or in the open air. He also collected on a sheet of oil-cloth, enough of the spray to get a taste of it. He found no sweetness about it and, so far as he could tell, it was pure water. He concluded that the honey-sac must be a sort of laboratory or filter.

Other observations on the tiny jet of colorless liquid ejected by bees working on thin syrup or nectar are so numerous that only a few of the more important ones can be mentioned in this brief discussion. E. R. Root (4) relates that his father once collected the spray from bees working on the spider plant, by catching it on dinner plates and after tasting it, decided it was nothing but water. He found also that upon evaporating, no deposit was left on the plates. For comparison, he collected nectar direct from the plants and found it decidedly sweet.

Brunnich has developed an interesting theory in explanation of this supposed reduction in water content while the nectar is in the body of the bee. Microscopic studies (5, 6) which he made on the internal anatomy of the bee led him to believe that the honey-sac is a sort of semi-permeable membrane through which a part of the water of the nectar passes into the blood from which it is removed by the so called "rectal glands" which discharge it into the rectum.

In support of this theory, Brunnich (6, 7) cites the work of Huillon as well as experiments of his own. During a good honeyflow, Huillon took away all the combs from three colonies one evening and the following morning gave them empty combs. From colony 1, he removed these combs in the evening of the same day. From colony 2, the combs were removed the next morning. Colony 3 was placed in the cellar on the evening of the first day and was left there three days, after which the combs were removed. After being extracted, the specific gravity of the three samples thus obtained was found to be: 1.394, 1.415 and 1.432 for colonies 1, 2 and 3 respectively. These densities correspond respectively to 26, 22 and 17 per cent water. Since ripe honey often contains as much as 20 per cent water these results would indicate that the samples from colonies 2 and 3 were both practically ripe so far as water reduction was concerned, and that the sample from colony 1 had been reduced in water content to a much greater extent than could be accounted for by evaporation from the nectar while stored in the cells.

Brunnich (6) showed by an experiment that a comb containing fresh honey left in a strong colony, but protected by wire-cloth so that no bee could reach it with its tongue, changed in density only from 1.288 to 1.340 during a period of eleven days of fine weather. Since it has been rather commonly observed that new honey normally ripens in about three days, we come to the conclusion that ordinary evaporation from the cells does not account for a very important part of the water reduction process.

The writer (8) has shown that the house-bees greatly facilitate the evaporation process by causing the nectar held in their honey-sacs to flow out in a thin layer over their tongues. The agitation caused by forcing it out and drawing it in also hastens evaporation. But this method does not account for the colorless liquid ejected by field-bees on the way to the hive; nor does it conflict in any way with Brunnich's excretion theory.

It has been shown that the excretion theory is supported by considerable evidence and, so far as the writer is aware, there is only one little bit

of evidence against it, and that is the fact that bees carrying only water have been reported, in a few cases, to eject colorless liquid in a manner similar to those carrying thin syrup or nectar. This may possibly be accounted for by the fact that most field bees have been found to carry a small quantity of honey in their honey-sacs when leaving the hive. If water be added to this, the result is a dilute sugar solution, which is exactly the case when bees feed on thin syrup or nectar.

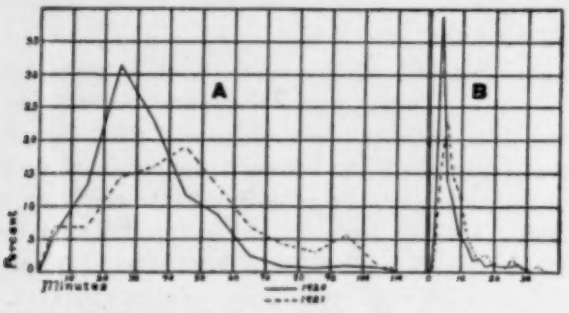

FIG. 39.—Showing the frequency distribution of time records made by nectar-carriers under *favorable* and *unfavorable* honey-flow conditions. A, Field trip records. B, Hive stay records.

With all of this evidence before us, it appears to the writer that we are warranted in concluding that the product which the nectar-carrier delivers at the hive has already lost a considerable part of its original water content. It is then to be expected that very few, if any, loads of nectar would reach the hive with a sugar content of less than 30 per cent; and, if not, then the filter paper test should be wholly reliable for the purpose of distinguishing between nectar-carriers and water-carriers. Moreover, a test sufficiently delicate to detect the presence of still smaller percentages of sugar might fully be expected to lead the investigator into error by showing the presence of some sugar in the honey-sac contents of a bee primarily engaged in carrying water.

CHEMICAL TESTS

The question naturally arises as to whether or not a chemical test might be applied which would show positively the presence or absence of sugar even in a fraction of a drop of solution. It is true that such tests exist but, unfortunately, all those of which the writer has any knowledge are wholly unsuited to the needs of the case. Dilutions to 0.00001 of one per cent of sugar can be detected by Molisch's reagent but the presence of a fiber of filter paper or even a hair from the body of a bee is sufficient to vitiate this test. The phenylhydrazine method requires the use of laboratory facilities and results can be known only after the lapse of an hour or more. Furthermore, some of the sugars

commonly present in nectar cannot be detected by this method. Other methods seem even less promising; and, so far, skilled micro-chemists have been unable to suggest a practical solution to this problem.

For the present then, it seems we must rely upon the use of the filter paper method, crude though it may be. The fact that in practical use in its original form during a period of several years, the filter paper test has been found entirely trustworthy for detecting nectar-carriers and water-carriers, indicates that it is adequate for this purpose.

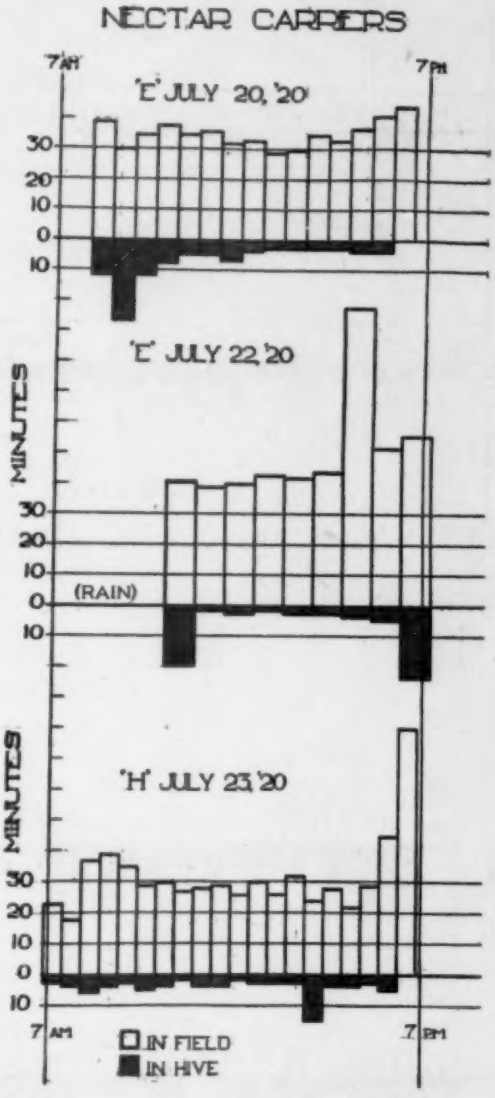

FIG. 40.—Typical time schedules of nectar-carriers.

RESULTS OBTAINED

Just a few of the results made possible by the use of this filter paper test may be of interest. A few nectar-carriers were found to make as many as 25 trips in a day. When good average strength colonies were gaining about 5 pounds per day net, from white sweet clover (1920), nectar-carriers were found to be making an average of 13 trips per day. As shown in Fig. No. 39 they spent about 25 minutes in the field and about 3 minutes in the hive between trips. Typical time schedules of nectar-carriers in 1920 are shown in Fig. No. 40. During a less favorable season (1921) when good average strength colonies were

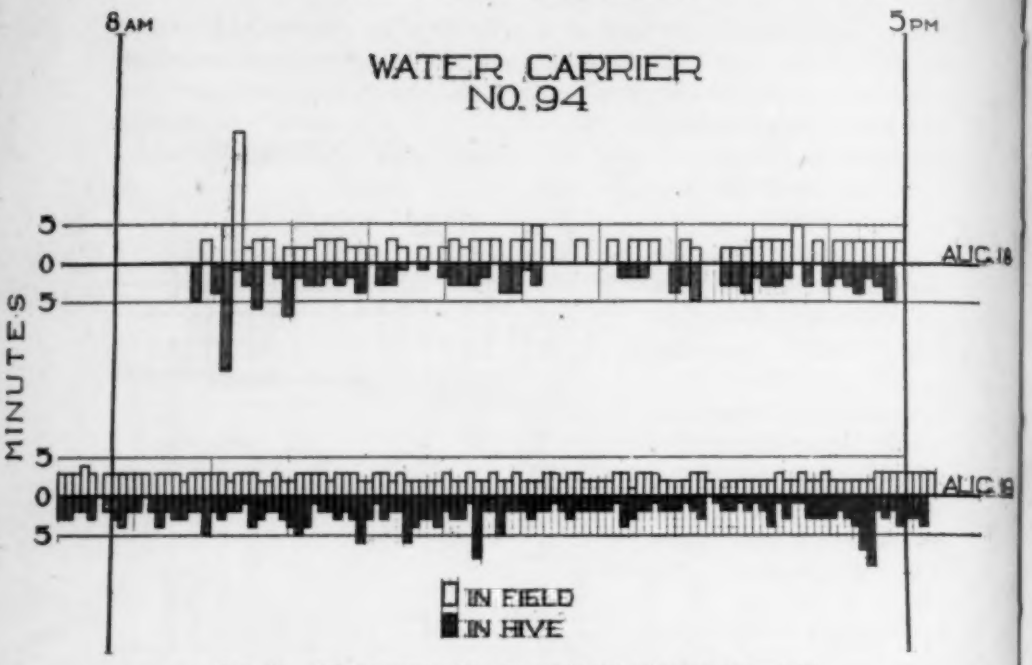

FIG. 41.—Water-carrier No. 94 made 114 trips on August 19.

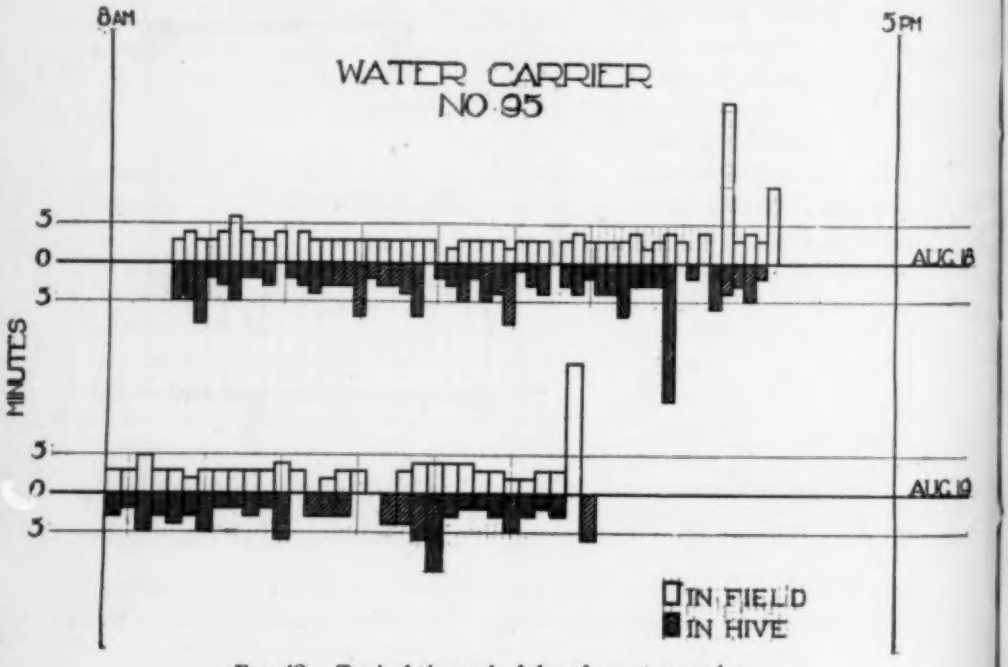

FIG. 42.—Typical time schedules of a water-carrier.

gaining only about 1 pound per day from the same source, nectar-carriers made an average of 8 trips per day. They spent about 45 minutes in the field and 4 in the hive, disposing of the load. It is to be observed that during the less favorable season, the hive stays were very slightly increased in duration while the field trips were lengthened by more than 50 per cent; and the number of trips per day was reduced to about two-thirds of what it was during the more favorable season.

Water-carriers were found to make as many as a hundred trips in a day in some cases. In fact, one of them made 114 trips one day, as is shown in Fig. No. 41. Typical time schedules of a water-carrier are shown in Fig. No. 42. The distance traveled for water makes a great difference on the length of the field trip. Water was available within a stone's throw of the apiary and, no doubt, most of the marked bees were going no farther as they spent only about 2 to 3 minutes away from the hive and a similar period inside the hive at each trip, as may be seen from Fig. No. 43. One marked bee, however, found to be going to a bucket of salt water two-thirds of a mile from the hive, spent from 8 to 10 minutes away from the hive while its hive stays were of about the same duration as those of other water-carriers.

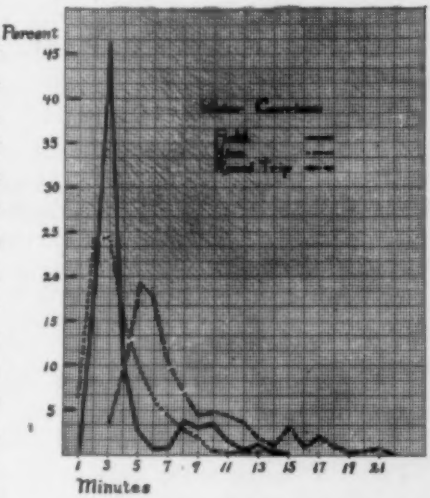

FIG. 43.—Showing the frequency distribution of time records made by water-carriers.

In addition to such data as given above, the filter paper test has made it possible to make numerous careful studies on the behavior of nectar-carriers and water-carriers in observation colonies, and to know with a satisfying degree of certainty, the occupation of each marked bee.

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INSECT ENEMIES OF SUGARCANE IN WESTERN MEXICO

By R. H. VAN ZWALUWENBURG, *Assistant Entomologist, H. S. P. A. Experiment Station, Honolulu, T. H.*[1]

ABSTRACT

The major sugarcane pests in western Mexico are two moth-borers, *Chilo loftini* Dyar and *Diatraea lineolata* Walker. Neither is held in check by parasites although the latter is fairly well parasitized by *Trichogramma* late in the summer and is of secondary importance after the first crop. *Leptodictya tabida* H. S. is everywhere common but is of slight economic importance. A noctuid larva, *Saccharaphagos mochisa* Schauss is sometimes numerous in ratoon fields, where also occur two species of *Cirphis*. *Tomaspis posticata* Walker has lately become a pest of some importance.

The most serious enemies of sugarcane in the state of Sinaloa[2] are two pyralid moth-borers: *Chilo loftini* Dyar and *Diatraea lineolata* Walker. Of these the former is by far the more important, due to the fact that it breeds without interruption throughout the year and is not seriously affected by parasites.

Chilo loftini DYAR

The infestation by *Chilo* is always heavy, ratoon cane[3] suffering about the same as plant cane. During the 1923–24 season the infestation of plant and ratoon cane at Los Mochis was as follows: 85% of all the stalks were infested and about 14% of all the joints.

[1]The author is indebted to Mr. H. T. Osborn for permission to include herein some of his observations on Mexican cane insects.

[2]Los Mochis, where most of the following observations on sugarcane insects were made, is in the state of Sinaloa in western Mexico, just below the 26th parallel of latitude and about 15 miles inland from the Gulf of Lower California. The annual mean temperature is about 75°F. with a mothly mean ranging from 63°F. in January to 87°F. in August. There is usually a well-defined rainy season during July, August and September with an average annual precipitation of about 14.5 inches.

[3]Ratoons spring from the old stool after the preceding crop is cut. Plant cane is the first crop, and the first, second and third ratoons are respectively the second, third and fourth crops from the same planting.

The characteristic injury by *Chilo* is a transverse tunnelling, usually just under the rind. The insect is small and the damage of each individual slight; the greater part of its injury is secondary due to fungous invasions. In plant cane the ravages of rind disease (caused by *Melanconium sacchari*), following borer injury, are sometimes enormous, especially if the cane is held over for late harvesting. Red-rot (caused by *Colletotrichum falcatum*) is also generally present in bored cane, causing a breaking down of the sucrose in the invaded areas. In high winds, *Chilo* is directly responsible for much breaking over of standing cane at the points where the transverse tunnelling takes place.

Chilo breeds throughout the year and in spring requires about 60 days for a complete generation. The eggs are yellowish and irregularly globular, lop-sided in appearance. In the laboratory they are usually inserted between the leaf-sheath and the stalk, although sometimes laid upon the leaf blade. They are deposited singly or in small irregular clusters and are extremely hard to find in the field. Upon hatching, which in the spring occurs about 5 days after the eggs are laid, the young larvae attack the cane in various ways. On the leaf they feed upon the epidermis or drill through the rolled-up inner leaf; in older cane they enter the cellular structure of the leaf-sheath, later entering the stalk itself, very often through the soft tissue about the "eye" or bud. The larvae are a dirty white with purplish-red markings which are practically the same in both newly-hatched and in mature larvae. Their feeding within the stalk, while sometimes longitudinal instead of transverse, is almost invariably just under the rind. The pupa is formed in a loosely-spun cocoon after an exit from the gallery has been cut to the outside. The adult is an inconspicuous straw-colored moth somewhat resembling *Diatraea*, but though varying considerably in size it is never so large as even the male of *Diatraea*.

Chilo attacks practically all the grasses large enough to afford it shelter within the stalk. We have bred it from sugar cane, corn, rice, *Panicum* grass, Johnson grass, sorghum and an unidentified native river-cane. It was originally described from sugar cane in southern Arizona, and we have seen the larva in sugar cane in the states of Sinaloa, Nayarit and Colima. We did not observe it farther south in the state of Vera Cruz or in the Tehuantepec region of Oaxaca.

Native Parasites of Chilo. *Chilo* is parasitized at Los Mochis by at least three native hymenoptera. Of first importance is *Chelonus sonorensis* Cam. which is sometimes abundant on the host in rice, but appears to be ineffective when the *Chilo* is in cane. During the spring of

1924, this braconid parasitized about 23% of the *Chilo* present in volunteer rice. *Chelonus* oviposits in the eggs of the host, which hatch normally; when the host larva is about half-grown the parasite issues and spins its cocoon in the tunnel near the larva. *Chilo* eggs exposed to *Chelonus* in the laboratory late in May resulted in adult braconids 35 days later. Unfortunately, evidence is at hand to indicate that *Chelonus* is hyperparasitized by what is probably a species of *Rhyssalus*.

Two species of ichneumonids, one a *Mesostenus*, and the other a *Mallochia* are sometimes fairly numerous on *Chilo* in both rice and sugar cane at Mochis, but are not so common as *Chelonus*. A second species of *Mallochia* was reared by the writers from a *Chilo* tunnel in sugar cane at Manzanillo, Colima.

Diatraea lineolata WALKER

The principal species of *Diatraea* in sugar cane at Mochis is *lineolata* Walker which breeds also in corn, rice and certain of the larger grasses. Two other species also occur in that part of the country: *D. grandiosella* Dyar in corn (a tentative identification by Mr. Wm. Schauss) occurring also in the state of Jalisco and *D. canella* Hamps. reported by Mr. T. E. Holloway of the U. S. Bureau of Entomology at Villa Union in the southern part of Sinaloa and probably occurring also in Nayarit.

The infestation by *Diatraea* in sugar cane at Los Mochis during 1924, was somewhat lower than in the two previous crops and was as follows:

	Per cent stalks infested	Per cent joints infested
Plant cane	60%	8%
Ratoons	35%	4%

Diatraea is primarily a test of plant cane in western Mexico. This is because of the following reasons: (1) the principal source of infestation is the cane planted in the fall and winter for the new crop; the overwintering generation issues through the new shoots which are well above ground by the following spring; (2) ordinarily cane from new fields is planted instead of using the less-infested cane from ratoon fields for planting; (3) the plant cane fields are always harvested early in the season (December to February) at which time the borer is present only in the larval stage, the bulk of the larvae therefore is passed through the mills with the cut cane, and only the comparatively few larvae remaining behind in the stubble are left to infest the ratoon crop.

Although larvae are present feeding throughout the year *Diatraea* lays no eggs from about the first of October to about the first of May. It passes the winter in the larval stage and pupates in the spring. There are not over three generations a year at Los Mochis and possibly only

two. During the late summer months from six to seven weeks are necessary for a generation. The eggs are laid exposed on the leaf, either singly or in small clusters which we have never found to contain more than eight eggs. The eggs are disc-shaped and when in clusters overlap one another like shingles. They are creamy-white when first laid, but later become orange; about four days before hatching they acquire three dark-red transverse stripes. They hatch in from six to eight days. The young larvae feed either upon the epidermis of the leaf, or make a short tunnel in the midrib, eventually leaving it as they make their way downward toward the stalk. The characteristic injury by this species is the longitudinal tunnel in the stalk which in the case of the full-grown larva approximates the diameter of a lead pencil and may extend through several internodes. In the field the pupae begin to form in late March and early April. The earliest record we have of adult emergence is May 4; the latest record of eggs in the fall is October 7.

Native Parasites of Diatraea. *Diatraea* is heavily parasitized by *Trichogramma minutum* Riley. This attacks the eggs of the first generation in May and June, and by the close of the oviposition season parasitizes the eggs of the last generation to the extent of over 70%. An unidentified ichneumonid is the only other known native parasite of *Diatraea* in Sinaloa, and is extremely rare.

At Tepic, Nayarit, Mr. Holloway reared a dexiid fly, *Phorostoma* sp. from *Diatraea* in sugar cane, and we have seen what is probably the same species farther south in the state of Colima.

Mr. T. C. Barber of the U. S. Bureau of Entomology records a parasitism of over 50% by *Apanteles diatraeae* Mues. on *Diatraea* sp. in corn in the state of Morelos, and has collected the same species in the state of Tamaulipas. The author has reared the same species from material collected in *Diatraea* tunnels in sugar cane in the province of Matanzas, Cuba, where it appears to be uncommon.

Introduced Parasites of Diatraea. In the summer of 1922 the author shipped from Cuba to Los Mochis 2544 puparia of diptera reared from *Diatraea*. From these 590 adult flies were released in the Mochis fields. Two species were involved: *Euzenilliopsis diatraeae* Towns. and *Sarcophaga sternodontis* Towns. Neither species has since been recovered at Los Mochis.

Euzenilliopsis is a very efficient parasite of *Diatraea* in Cuba, and has been successfully established by Mr. Holloway and Mr. E. R. Barber of the U. S. Bureau of Entomology in Louisiana. It was later (1924) introduced by Mr. Harold E. Box into British Guiana. It occurs in

Cuba in Porto Rico with *Diatraea* its only known host. We reared it in Cuba only from the larval stage.

Sarcophaga sternodontis we reared only from the pupa and it may be a scavenger rather than a parasite. It has been recorded from Louisiana, Florida, the West Indies, Brazil and Ecuador.

Following information from Mr. H. T. Osborn, then of the Hawaiian Sugar Planters' Association Experiment Station, introductions of a tachinid parasite of *Diatraea*, *Paratheresia signifera* Towns. were made in 1923 from the state of Vera Cruz to Los Mochis. According to Mr. Osborn's observations this parasite was most numerous in the spring months. The species is recorded from Tucuman, Argentina, from the coastal region of Peru, and from Honduras as well as from Vera Cruz.

Through the kindness of Dr. L. O. Howard and Mr. Holloway, a colony of *Habrobracon brevicornis* Wesm. was sent from New Orleans to Los Mochis in the spring of 1923. These were increased by breeding on *Diatraea* in the laboratory to considerable numbers before releasing in the field. In the laboratory the species accepted *Diatraea* larvae readily and in one instance we succeeded in forcing oviposition upon *Chilo*, one resulting individual reaching the adult stage.

Minor Insects of Sugar Cane

Next to the moth-borers the most common insect on sugar cane in Sinaloa is the sugar cane lacewing, *Leptodictya tabida* H. S. This occurs also on corn and sparingly on bamboo. It sometimes becomes very abundant on old cane, but seldom does any great damage. By the time it has fed to the extent of seriously drying the leaves, their function has already been taken up by the newer leaves. The prevalent practice of burning the cane fields previous to harvesting no doubt serves to hold the species in check. It is widespread throughout the country, being recorded from Lower California and from Vera Cruz and is commonly found wherever cane is grown on either seas-board and also inland on the Isthmus of Tehuantepec.

A noctuid moth, *Saccharaphagos mochisa* Schauss, occasionally becomes abundant in old ratoon fields. The larva is very active, a dirty white with a dark-brown head capsule, and is about an inch and a quarter long when full grown. It often gnaws a rough cavity at the base of the stalk, seldom progressing further than a single joint. This feeding habit may not be the usual one for we have found the larva in soil about the roots of corn. In abandoned fields the larvae are sometimes found feeding in the trash about the sprouted eyes several feet above ground. Mr. Osborn reports finding the larva about cane roots in the state of Jalisco. He also notes the species as unusually abundant on

a plantation near Mochis in the late summer of 1925, so it may eventually become more important than it has been hitherto.

Mealy-bugs are uncommon on sugar cane on the west coast. Mr. Osborn found *Pseudococcus boninsis* Kuw. on cane near Culiacan in the center of the state, and on one of the plantations near Mochis a slight infestation of what appeared to be *Trionymus sacchari* Cock. has occurred.

A chrysomelid beetle, *Diabrotica fenestralis* Jacoby, sometimes injures young cane along the margins of fields by its feeding on the leaves. Its favorite food-plant is *Amaranthus* and it is never injurious in fields which are well weeded.

Old ratoons are sometimes attacked by *Cirphis latiuscula* H-S. and *Cirphis cholica* Dyar. Mr. Osborn found that *Apanteles militaris* Say is a fairly abundant parasite on these species during the winter months, and that two tachinids also occur on these hosts: *Archytas cirphisae* Curran[4] and *Spallanzania hesperidarum* Will. Mr. Osborn sent shipments of these parasites to Hawaii during the winter of 1923-24, and one of them, *Archytas cirphisae*, has since become widely established on the island of Oahu in an incredibly short time.

The homoptera are represented in the Sinaloa cane fields by *Acanalonia bivittata* Say, *Stictocephala festina* var. *rufivitta* Walker, *Draeculacephala mollipes* Say and *Tomaspis postica* Walker. The last-named is reported by Mr. Osborn as becoming injurious on cane near Mochis in the late summer of 1925, dying off or at least disappearing by the first of November.

Blissus leucopterus Say is sometimes found on cane at Mochis.

A single specimen of *Sphenophorus reticulaticollis* (var.) Boh. was reared from sugar cane in 1922 at Los Mochis, and occasionally an adult is found in the field. Its more usual host according to Dr. E. C. Van Dyke who identified the specimens, is the common cat-tail or tule.

Notes on Cane Insects in Eastern Mexico

Besides at least two species of *Diatraea* present in the state of Vera Cruz, the following pests of sugar cane occur there:

A small moth-borer spinning a cocoon within the cane, *Xubida dentilineatella* Bnes-McD., first observed by Mr. Osborn, and its host previously unknown. It is not at all common and is parasitized by the tachinid, *Masicera tantilla* Vanderwulp.

In parts of Vera Cruz and Puebla there are occasional outbreaks of *Sphenophorus incurrens* Gyll., usually in old fields according to Mr. Osborn. It is parasitized by *Miophasia metallica* Towns. which is sometimes very abundant and appears to hold the beetle in check.

[4]Identified by Mr. Curran; description not yet published (Dec. 1925).

Scientific Notes

Apple Curculio. A very abnormal attack of the apple curculio, *Tachypterellus quadrigibbus*, has taken place in a cherry orchard of several acres near Fort Collins, Colorado. At least 98 per cent of the cherries have been punctured by this insect and a large percentage of these cherries have the larvae in the pits at the present time. Apples in the vicinity of this cherry orchard are also quite seriously stung and about one in six of these have the eggs or the larvae present at this time (June 20) in the punctures.

C. P. GILLETTE, *State Entomologist, Fort Collins, Colo.*

The Possibilities of Sodium Fluosilicate as a Poison in Grasshopper Baits. In the fall of 1924, Dr. L. B. Ripley reported sodium fluoride as a promising poison for the brown locust in the Union of South Africa. Therefore, in the summer of 1925 the writer, with the assistance of Mr. K. D. Arbuthnot, attempted to poison a four-acre plot of freshly cut alfalfa to determine the efficiency of this material against the common injurious species of grasshoppers in Colorado. Excellent results were obtained. Encouraged by this experiment and having in mind Mr. S. Marcovitch's experiments with sodium fluosilicate as a poison for the Mexican bean beetle, a series of laboratory experiments were undertaken to test the efficiency of sodium fluosilicate as a poison in grasshopper bait. The species of grasshoppers used in the experiments were mostly *Melanoplus femur rubrum* Degeer. In the series of experiments sodium fluosilicate seemed to be quite effective. In comparison with paris green, white arsenic, sodium arsenite and sodium fluoride used in baits in the same way, under the same conditions and at the same time it ranked above all, both in the percentage of kill and the time required for killing. The percentage of kill for all the poisons was as follows after six days:

Sodium fluosilicate	100 per cent (4 days)
Sodium fluoride	92 "
Paris green	98.7 "
White arsenic	98.2 "
Sodium arsenite	96.5 "
Check	30.3 "

The baits used were all made according to standard formula. Where sodium fluoride and sodium fluosilicate were used as the poisoning agent they were used at the rate of four pounds to each 100 pounds of bran. The "wet" method was employed in the mixing of the baits.

GEORGE S. LANGFORD, *Deputy State Entomologist, Fort Collins, Colo.*

Blowflies, Woodpeckers and Shingles. Last June, as a result of woodpeckers in the Adirondacks drilling a shingle roof apparently in search of borers, it was found that with very little question they were after a blowfly, the latter kindly identified by Dr. J. M. Aldrich of the National Museum as *Protophormia terrae-novae* R. D. The insects were so abundant that striking the shingles resulted in driving large numbers of flies from their shelters. They had apparently taken refuge under the shingles and their buzzing betrayed them not only to the woodpeckers but also to the owners of the camp. Mr. Howard Notman advises us that he has found swarms of similar flies in crevices in the rocks on some of the mountains in that section. Portions of the shingle roof were very badly damaged, several hundred holes being drilled by the birds in their efforts to get at the flies and in every instance the hole was made in the crack between two shingles. It should be stated that woodpeckers were not actually observed at work upon the roof, though the character of the injury prevents it being attributed to any other agency. E. P. FELT

Effect of the Order of Mixing Various Spray Ingredients, on the Formation of Injurious Compounds. A study of the common sprays used on apples in Connecticut has been made from the standpoint of arsenic and sulphur in solution—influenced by the order of mixing the separate ingredients. Thus with four ingredients 24 different combinations are possible, all of which have been made and analyzed in the laboratory. For the sake of comparison, analyses were also made of combinations of two and three ingredients. The anlyses were made by a special method which is believed to be more accurate than those used heretofore. The data obtained indicate some variation in soluble arsenic and sulphur, but the variations in most cases are so small that it does not seem advisable to draw definite conclusions regarding their value. There are strong indications of the formation of colloidal sulphur in some combinations which appears in the filtrates as a decided turbidity. There is also a distinct color reaction between nicotine sulphate and lime-sulphur which may cause the solution to become dark in color, but does not show up in chemical analyses of sulphur or arsenic. Probably some other reaction is responsible. At any rate, the solution, although dark in color, may be satisfactory from a chemical standpoint.

Nicotine sulphate does not play an important part in the reactions involved and may even be beneficial in some combinations. From a chemical standpoint, at least, it may be disregarded as a source of trouble in producing spray burn through the formation of soluble arsenic.

There appears to be little doubt that pure lime or casein-lime in amounts used in the more common formulae will decrease the amount of soluble arsenic formed in the spray mixture; but there is also danger of decreasing the sulphur in certain combinations (Table 1, Nos. 5 and 12). What effect this reduction in sulphur has in actual practice remains to be determined, but it seems quite probable that the value of the mixture is decreased considerably, especially if there is no turbidity of the filtrate.

More complete results will appear as Bulletin 278 of the Connecticut Agricultural Experiment Station.

EFFECT OF DIFFERENT ORDERS OF MIXING ON QUADRUPLE MIXTURES

Exp. No.	Order of mixing 1	2	3	4	Physical characteristics Color of finished mixture	Color of sediment	Filtered solution	Arsenic As_2O_3 per cent Based on amount of lead arsenate used In L.-S. solution %	Water-soluble in sediment %	Total soluble %	Total sulphur in lime-sulphur solution gm. 100 cc.
1	L. A.	N. S.	C. L.	L. S.[1]	Light	G. B.	Clear	0.40	2.55	2.95	.930
2	L. A.	C. L.	N. S.	L. S.	Dark	G. B.	Clear	0.47	2.83	3.30	.925
3	L. A.	L. S.	C. L.	N. S.	Light	G. B.	Turbid	0.43	1.19	1.62	.915
4	L. A.	L. S.	N. S.	C. L.	Light	Blk.	Turbid	0.71	1.62	2.33	.827
5	L. A.	N. S.	L. S.	C. L.	Light	Blk.	Clear	0.81	0.29	1.10	.716
6	L. A.	C. L.	L. S.	N. S.	Dark	G. B.	Turbid	0.50	2.33	2.83	.916
7	N. S.	L. A.	C. L.	L. S.	Light	G. B.	Clear	0.39	2.55	2.94	.919
8	C. L.	L. A.	N. S.	L. S.	Dark	G. B.	Clear	0.60	2.65	3.25	.916
9	L. S.	L. A.	C. L.	N. S.	Light	G. B.	Turbid	0.47	0.98	1.45	.907
10	N. S.	L. A.	L. S.	C. L.	Light	G. B.	Turbid	0.29	1.33	1.62	.912
11	C. L.	L. A.	L. S.	N. S.	Dark	G. B.	Clear	0.69	2.60	3.29	.918
12	L. S.	L. A.	N. S.	C. L.	Light	Blk.	Clear	0.90	0.41	1.31	.678
13	N. S.	L. S.	L. A.	C. L.	Light	Blk.	Clear	0.55	2.31	2.86	.800
14	C. L.	N. S.	L. A.	L. S.	Dark	G. B.	Turbid	0.33	2.77	3.10	.920
15	L. S.	C. L.	L. A.	N. S.	Dark	G. B.	Turbid	0.55	1.35	1.90	.912
16	L. S.	N. S.	L. A.	C. L.	Light	Blk.	Clear	0.65	2.40	3.05	.838
17	N. S.	C. L.	L. A.	L. S.	Light	G. B.	Clear	0.41	2.56	2.97	.906
18	C. L.	L. S.	L. A.	N. S.	Dark	G. B.	Turbid	0.50	2.80	3.30	.922
19	N. S.	L. S.	C. L.	L. A.	Light	G. B.	Turbid	0.40	1.06	1.46	.907
20	C. L.	L. S.	N. S.	L. A.	Dark	G. B.	Clear	0.50	2.69	3.19	.906
21	L. S.	C. L.	N. S.	L. A.	Dark	G. B.	Clear	0.48	1.71	2.19	.916
22	C. L.	N. S.	L. S.	L. A.	Dark	G. B.	Clear	0.41	2.54	2.95	.913
23	L. S.	N. S.	C. L.	L. A.	Light	G. B.	Turbid	0.39	1.40	1.79	.907
24	N. S.	C. L.	L. S.	L. A.	Dark	G. B.	Clear	0.48	2.73	3.21	.916

[1] L. A. = Lead Arsenate. N. S. = Nicotine Sulphate. C. L. = Casein Lime. L. S. = Lime Sulphur Solution. Blk. = Black. G. B. = Grey Black.

R. E. ANDREW and PHILIP GARMAN

JOURNAL OF ECONOMIC ENTOMOLOGY

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AUGUST, 1926

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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The last thirty years have witnessed enormous strides toward specialization and if differentiation alone is a test of progress, this means a wonderful advance. Tendencies along these lines are perhaps as marked in entomology as in any branch of natural history. Some, though by no means all, of this differentiation may have been stimulated by the recent developments in economic entomology, a phase where exact discrimination is a practical necessity. The long lists of new species and genera in the aphids, the scale insects, mosquitoes, thrips and gall midges illustrate the modern tendency in some of the less known groups since the beginning of this era. We have in the Culicidae a taxonomic tangle so complex that its elucidation is a "confusing and almost impossible undertaking." We are approaching, if we have not all ready attained, a similar condition in the Aphididae. There is serious confusion in the Cynipidae due in large measure to biological peculiarities in the group. These are but illustrations in some of the minor groups. The relatively well known Coleoptera are not free from perplexities. A reviewer of the work of a noted coleopterist intimates the separation of species on undescribable characters and suggests the approach of "intellectual bankruptcy." It is not for us to pass on the merits of the opinion. It appears probable that an approach to the conditions alleged in the Coleptera may be found in other major groups and is suggestive of what may be in the future. Only an ardent enthusiast can view the nomenclatural situation with complacency. Nature is exceedingly complex. Distinctions must be recognized otherwise identifica-

tion is impossible. The work of the specialist is necessary, yet it should be carefully studied by the general naturalist and a serious effort made to adapt the system to the needs of all. The economic entomologist may render a distinct service in this direction.

Obituary

AN IMPERIAL ENTOMOLOGIST IN FACT

In the January (1926) number of the Agricultural Journal of India, M. Afzal Husain, the Acting Imperial Entomologist of India, gives a brief acccunt of the life and work of the late Professor Harold Maxwell-Lefroy, M. A., F. E. S., F. Z. S., which is accompanied by a halftone reproduction of his photograph.

The life work of the late Prof. Maxwell-Lefroy is well known to the older American entomologists, who followed it from the time he commenced his service as Entomologist to the West Indies in 1899 up to his untimely death on October 14, 1925, while conducting investigations at the Imperial College of Science and Technology, at London, in the attempt to utilize one of the more toxic gases in insect control. It is not the reference to his life work that attracts our attention to this obituary, for other more extended accounts have appeared, but rather the tribute paid by a former assistant and associate to his worth from the humanitarian side. In the words of Mr. Afzal Husain, "his magnetic personality affected all who came in contact with him, and he infused in his coworkers and pupils the same enthusiasm for work which he himself possessed. Generations of students at the Imperial College of Science and Technology will hear of his zeal and enthusiasm for entomology, his sympathy for his pupils, and his anxiety to render every possible assistance to those who deserved it. In India, he will be long remembered by his coworkers as a generous officer and a perfect gentleman."

What greater tribute could be paid to a man that has risen to high position than this, that he was possessed of such enthusiasm and magnetic personality as to infuse it into coworkers and pupils, a sympathy for his pupils, and an anxiety to render every possible assistance to those who deserved it—a generous officer and a perfect gentleman. Possessed of such characteristics as a teacher, investigator, and executive, what less could be expected than the attainment of the high position to which he rose as Imperial Entomologist of India and as an author of works on entomology. Would that others possessed of such high

scientific attainment, accompanied by such a broad human sympathy and the power to inspire others might rise up to take the places in the world left vacant by such as he.

W. A. H.

CAMILLO GOLGI, 1843–1926

In the March number of the Journal of the Royal Microscopical Society (pp. 31–34), an account is given of the life and work of Prof. Camillo Golgi, accompanied by a halftone reproduction of his photograph. This Italian scientist, who was born in Corteno, on July 1, 1843, and died on January 21, 1926, was a member of the Italian Senate for a number of years and winner of the Nobel Prize in 1906. He is perhaps best known to the scientific world through his discovery of the chromate of silver method, by means of which nerve cells, with all their processes and the finest ramifications of the latter, can be seen singled out and intensely stained black against a transparent yellowish background.

"At a time when histological technique was in its infancy, and the structure of the central nervous system looked like an impenetrable mystery, Golgi's discovery revealed the existence of an unforeseen world . . . . By means of Golgi's methods the microscopical anatomy and physiology of the central nervous system were placed on the sound foundation on which they at present rest."

In the field of pathology his researches on malaria, from 1885 to 1893, are of particular interest to the entomologist. After Laveran's discovery, Golgi gave a masterly description of the parasities of the tertian and quartan fever and their nonsexual cycle of development. By showing that the beginning of fever in malaria coincides with the sporulation phase, taking place at intervals definite for each species of the parasite, he led the way to the rational use of quinine in the struggle against this scourge of humanity.

W. A. H.

Current Notes

Mr. E. Piazza, a successful collector of moths, died in New York, March 9, 1926.

According to the *Experiment Station Record*, Mr. Joseph Polivka has been appointed assistant in entomology at the Ohio Station.

Leave of absence for the spring term was granted to Professors Glenn W. Herrick and Cyrus R. Crosby of Cornell University.

Mr. H. K. Plank, of the Bureau of Entomology, has resigned to accept a position with the Tropical Plant Research Foundation in Cuba.

Dr. Herbert Osborn, Research Professor of Entomology, Ohio State University, recently visited the Boyce Thompson Institute for Plant Research.

A new agricultural building is now being erected at Arkansas University and Station which will house several departments, including that of entomology.

Professor G. M. Bentley, State Entomologist of Tennessee, attended the annual convention of the American Association of Nurserymen at Louisville, Kentucky, on June 22–25.

Mr. Luther Shirley West, Instructor in parasitology in the Entomological department of Cornell University, has resigned to accept a position in Battle Creek College.

Mr. H. F. Willard, in charge of the laboratory of the Bureau of Entomology at Honolulu, visited Washington recently to confer regarding plans for future work.

Mr. Henry L. Viereck has been given a temporary appointment in the New York State Museum at Albany and is working on the collections of Hymenoptera.

Professor and Mrs. E. Dwight Sanderson and Professor and Mrs. John H. Comstock of Cornell University were recent visitors at the Corn Borer Parasite Laboratory at Hyères, France.

Dr. Henry Skinner, entomologist and physician, vice-president of the Philadelphia Academy of Natural Sciences and formerly Editor of *Entomological News*, died May 30, aged sixty-five years.

According to *Science*, Professor F. L. Washburn of the University of Minnesota has returned from the islands of the South Pacific with several thousand insect specimens for his institution.

Mr. Roger B. Friend, Assistant Entomologist of the Connecticut Agricultural Experiment Station, who is pursuing graduate studies in Yale University, has also been appointed instructor in entomology in Yale University.

According to *Science*, Dr. Vernon Kellogg, Secretary of the National Research Council, expected to attend a special general assembly of the International Research Council at Brussels on June 29.

Messrs. A. K. Leith, for many years lay inspector at Winnipeg, Manitoba, and A. K. Gibson, inspector at Niagara Falls, Ontario, resigned on April 30 from the Canadian Department of Agriculture.

Dr. J. H. McDunnough left Ottawa on May 20 for Lillooet, B. C., to continue faunal studies of the Rocky Mountain region. He expects to be absent from headquarters until about the middle of August.

Mr. A. E. Warren, a graduate student of Yale University, has been engaged as assistant in entomology at the Connecticut Agricultural Experiment Station during the summer vacation and will help in the inspection of nurseries.

Mr. H. G. Crawford, Entomological Branch, attended a meeting of the United States and Canadian entomologists at Chicago, Illinois, on June 3, where various types of machinery used in control work against the European corn borer were discussed.

The corn stalk beetle, *Ligyrus rugiceps*, also known as the sugar cane beetle, *Ligyrus gibbosus*, is doing considerable damage to the corn crop in Tennessee. The army worm has made its appearance in different localities of the State.

Dr. W. W. Henderson has been appointed Head of the Department of Zoology and Entomology of the Utah Agricultural College in place of I. M. Hawley who resigned to enter the Federal service.

Dr. H. J. Pack has been appointed Entomologist of the Utah Agricultural Experiment Station in place of I. M. Hawley, who has resigned to enter the service of the Federal Bureau of Entomology.

Mr. Ira M. Hawley has resigned his position as Head of the Department of Zoology and Entomology of Utah Agricultural College and Entomologist of Utah Agricultural Experiment Station to accept the position of Entomologist in association with George I. Reeves, in the alfalfa weevil laboratory of the Federal Bureau of Entomology.

According to *Science*, Dr. David E. Fink, of the Bureau of Entomology, formerly stationed at Riverton, N. J., is now located in the department of Zoology at the University of Pennsylvania, where he will conduct physiological studies on truck crop insects.

According to *Experiment Station Record*, Mr. George D. Smith, associate entomologist in cotton insect investigations at the Florida Station, has resigned to enter commercial work, and has been succeeded by Mr. Edgar F. Grossman, formerly of the Georgia Board of Entomology.

Mr. S. M. Dohanian, formerly of the Bureau of Entomology, who has recently been employed on European work for the American Cyanamid Company of New York, returned May 6 to the Bureau work in the Gipsy Moth Laboratory at Melrose Highlands, Massachusetts.

Mr. Ezra Townsend Cresson, one of the founders of the Entomological Society of Philadelphia in 1859 (name changed to American Entomological Society in 1867), and one of America's foremost hymenopterists, died April 19, in the eighty-eighth year of his age.

Dr. W. H. Larrimer of the Bureau of Entomology, returned on May 18 from an extended field trip, during which he visited a number of the field laboratories, including those at Wichita, Kans., San Antonio, Tex., Tempe, Ariz., Sacramento, Calif., and Salt Lake City, Utah.

Mr. Dettmar W. Jones, of the Arlington, Massachusetts laboratory of the Bureau of Entomology, visited the Chatham, Ontario laboratory early in April, to confer with Mr. A. B. Baird of the Dominion Department of Agriculture, relative to the technique of handling parasites of the European corn borer.

In the July 1926 number of the *Scientific American*, Prof. T. D. A. Cockerell gives an interesting account of "Natural History for Tourists." To the entomologist the reproduction of a photograph of Professor Cockerell surrounded by his books and collection will prove to be of interest.

Mr. L. H. Worthley of the Bureau of Entomology, in charge of corn borer control, spent several weeks in May and June in the Middle West. He visited New Haven, Conn. on June 23. He has recently moved his storehouse from Arlington, Mass., to Stratford (near Bridgeport), Conn.

The following resignations in the Bureau of Entomology have recently been announced: Fred P. Amsler, temporary sweet potato weevil scouting in Alabama, to accept a permanent appointment with the Mississppi State Plant Board; H. K.

Plank, New Orleans, La., to accept a position with the Tropical Research Foundation in Cuba.

Mr. F. L. Campbell, having received the degree of Doctor of Science at the Bussey Institution of Harvard University, has been appointed Assistant Professor of Biology at the University Heights College of New York University. He will introduce courses in entomology and general physiology, paying particular attention to insect physiology.

According to *Science*, Professor Paul S. Welch of the Department of Zoology, University of Michigan, has returned after a sojourn of about ten months in Europe where he visited universities, research institutes, museums, and biological Stations in England, Scotland, France, Belgium, Holland, Denmark, Germany, Switzerland, and Italy.

Recent visitors to examine the investigation and control of the Asiatic beetle at New Haven, Conn. include Dr A. L. Quaintance, Washington, D. C., L. B. Smith, J. L. King and H. W. Allen, Riverton, N. J., Professor Ernest N. Cory, College Park, Md., C. H. Hadley, Harrisburg, Pa., and Dr. Thomas J. Headlee, New Brunswick, N. J.

Plans have been made to scout for the oriental peach moth in southern Ontario to determine its distribution, and it is expected that the work will be started in the near future. In addition to general scouting, permanent official points will be established where records will be taken each year.

By request, Dr. R. T. Cotton of the Bureau of Entomology on April 17 attended a demonstration fumigation of the sample rooms of the New York factory of one of the large candy-manufacturing companies, to determine the effectiveness of calcium cyanide as a fumigant under the conditions prevailing in such places.

Mr. Niils A. Vappula, of the Agricultural Institute of Finland, has been visiting the Bureau of Entomology for a few weeks. He has been sent to America by his government to investigate our methods in economic entomology, and planned to take a long trip, visiting some of the Bureau stations and other entomological centers.

Recent visitors to the U. S. National Museum include the following: Mr. H. F. Schwarz of the American Museum of Natural History, New York City; Dr. J. Chester Bradley, Cornell University, Ithaca, N. Y.; Dr. J. M. Swaine, Entomological Branch, Ottawa, Canada; Professor Herbert Osborn, Ohio State University, Columbus, Ohio; A. B. Champlain and J. N. Knull, Pennsylvania Department of Agriculture, Harrisburg, Pa.

Dr. C. L. Metcalf, head of the Department of Entomology, University of Illinois, was selected as lecturer in entomology for the Sixth Annual Convention of the Canadian Society of Technical Agriculturists, held at Ontario, Ottawa, June 23–26. He lectured on "Methods of Injury by Insects," and "Recent Developments in Control Measures." He also spent much time at the Branch studying the diptera in the National Collection.

The Proceedings of the Tennessee State Horticultural Society, State Nurserymen's and Beekeepers' Associations has been issued. This book contains 185 pages, giving lectures, papers and discussions at the annual convention of these live organizations. These proceedings will be sent free to members and are for sale at 50 cents per copy. Professor G. M. Bentley is the Secretary.

Professor Z. P. Metcalf, head of the Department of Zoology and Entomology, North Carolina State College and Experiment Station, spent the week of May 17 in the Library of Congress and at the Philadelphia Academy of Science making the final check on the "Bibliography of the Homoptera of the World," which is to be published this summer.

The campaign against the European earwig in Vancouver which is being financed by the city, was commenced on May 10. The work is under the direction of a campaign manager and Mr. R. Glendenning is acting in an advisory capacity. Mr. Glendenning reports that the earwig appears to be spreading, its presence having been reported from Abbotsford and Sardis.

Dr. A. L. Melander has been made Chairman of the Biological Faculty of the College of the City of New York. Last February, after twenty-two years of service as entomologist of the Washington Experiment Station, and since 1907 as head of the Zoology Department of the State College of Washington, Dr. Melander resigned to accept appointment at the College of the City of New York as Professor of Biology.

Noteworthy winter shipments of parasites from France to the Corn Borer laboratory at Arlington, Mass., have been as follows: 34,816 *Microgaster tibialis* Nees; 13,191 *Eulimneria crassifemur* Thom., and 355,400 host larvae from which four other species of parasites will be reared. The two parasites named above and *Phaeogenes planifrons* Wesm. and *Exoristes roborator* Fabr. have been recovered, the last-named species from Ohio, western New York, and from several points in the New England States.

Mr. L. F. Hitchcock, Biologist of the Commonwealth Prickly-Pear Board of Australia, and Mrs. Hitchcock visited the Bureau of Entomology early in April. Mr. Hitchcock is to take up the work in the United States and Mexico in relation to the insect enemies of the prickly pear. He reports that a number of the introductions into Australia made by his predecessors in this country have been successful and that they hope that the Opuntia problem will be solved in this way.

A seminar was inaugurated May 25 at Tallulah, La. with full attendance and enthusiastic interest on the part of the personnel of the Delta Laboratory of the Bureau of Entomology. Dr. J. W. Folsom, in charge of experimental detail, will preside at the weekly meetings for post-graduate study and discussion. All members of the Delta Laboratory organization located at Tallulah, from shop mechanics to administrative officers, are enlisted in this effort to bring the organization to the highest possible plane of coordinated efficiency.

On April 6, Dr. E. A. Back of the Bureau of Entomology gave a talk on the clothes moth problem before the Housekeepers' Alliance of Washington. On April 22, he visited a large woolen yarn and cloth manufacturing plant in Philadelphia, to investigate an outbreak of fabric pests, and to suggest methods of control suitable to local conditions. On May 15 he was present by invitation as an observer at the fumigation of a large cigar factory at Charleston, S. C., where 2,200 pounds of powdered calcium cyanide was used.

Recent appointments in the Entomological Branch, Canadian Department of Agriculture, have been announced as follows: F. A. Jeffrey, Ottawa, R. B. McCormack, Fredericton, N. B., R. Balck, Chatham, Ont., H. H. Ross, Agassiz, B. C., W. G. Mathers, Vernon, B. C., J. B. Mathieson, Victoria, B. C., E. D. Tinkham, Lethbridge, Alta, temporary insect pest investigators; G. A. Ficht, Chatham, J. B. Revell,

Lethbridge, Alta., R. M. White, R. D. Hurd, Treesbank, Man., E. McMillan, Saskatoon, Sask., temporary junior entomologists; J. J. Atkinson, Saskatoon, Sask., temporary assistant entomologist. Messrs. A. B. Baird, Chatham, Ont., and J. J. de Gryse, Ottawa, have been promoted from assistant entomologist to entomologist.

Mr. D. J. Caffrey has started work in the Bono, Ohio, district, in connection with the outdoor corn borer experiments which he inaugurated in that section last year. He has also been traveling in southern Michigan, where cooperative experiments will be carried on with agronomists and entomologists of the Michigan State College, dealing with the corn borer investigational work. Mr. Caffrey also visited Mr. H. N. Bartley, at the Silver Creek, N. Y., laboratory, and Mr. L. H. Patch, at the Sandusky, Ohio laboratory, to confer with them in regard to the corn borer work at these points.

Messrs. C. B. Hutchings, C. R. Twinn, W. St. G. Ryan and S. H. Short of the Entomological Branch, attended the annual meeting of the Quebec Society for the Protection of Plants, held at Macdonald College, Quebec, on April 15. The following papers were presented by Branch officers: "*Coleophora pruniella*, a Case-bearer Injurious to the Apple in Quebec," by Messrs. C. E. Petch and T. Armstrong; "Insects of the Season," by C. E. Petch; "Shade Tree Insects of Eastern Canada," by C. B. Hutchings; "Notes on the Mosquito Fauna of Quebec," by C. R. Twinn; and "The Gypsy Moth in Quebec," by S. H. Short.

Recent transfers in the Bureau of Entomology have been announced as follows: Curtis Benton, Corn borer control to Hessian fly investigations, West Lafayette, Ind.; George W. Barber, Corn borer laboratory, Arlington, Mass. to jointworm experiments, Charlottesville, Va.; L. L. Pierce, Arlington, Mass. to Sandusky, Ohio, Corn borer investigations; W. A. Stevenson and H. C. Young, Tallulah, La., to cotton boll weevil work in Arizona; W. V. Williams, Tallulah, La., temporarily to investigations of *Bucculatrix thurberiella*, which is causing serious injury to cotton in the vicinity of Calexio and El Centro, Calif., and in Lower California; G. L. Garrison, temporarily to tobacco insect investigations at Quincy, Fla.

Mr. S. H. Short is again in charge of the gypsy moth eradication and scouting work in Quebec, and is assisted by Mr. G. A. Tessier of the Quebec Department of Lands and Forests, as Associate General Foreman. The latter officer is in charge of the provincial staff this season. Mr. L. L. Reed of the St. John, N. B. inspection staff, will continue as crew trailer, and the various scouting crews will be in charge of the following officers as foremen: Messrs. E. Malloch, A. Audette, R. J. Letourneau, W. H. Barnett, P. Drolet and P. Masse. Mr. Malloch has been assigned to the Henrysburg district where special eradication measures are now being carried out.

Professor Sidney Irving Smith, Professor Emeritus of Comparative Anatomy in Yale University, died at his home in New Haven on May 6, aged 83 years. For many years Professor Smith had been almost totally blind but in his earlier years he studied insects and was entomologist of the Connecticut Board of Agriculture. In the Sixth Annual Report of the Board (1873) was published his report as Entomologist, which gave a discussion of the Orthoptera with a list of species which should be found in the State. In 1868 he published on the Orthoptera of the State of Maine (Proc. Portland Soc. Nat. Hist., 1, 143–151) in which he described *Melanoplus mancus*. He also described the moth, *Samia columbia* with other species in Proc. Boston Soc. Nat. Hist., ix, p. 343 (1865).

Dr. J. M. Swaine, Associate Dominion entomologist, recently visited the forest entomologists of the U. S. Bureau of Entomology and devoted a week to the study of the collections. On June 4 he left Ottawa for Halifax, Nova Scotia, where he was joined by Mr. Arthur Kelsall. A conference was held with representatives of the Provincial Department of Agriculture dealing with the apple maggot situation in Nova Scotia. Early in June Dr. Swaine visited Cape Breton, with Messrs. A. H. MacAndrews and O. Schierbeck, Chief Forester for Nova Scotia, to study an outbreak of the spruce budworm. An inspection was also made in parts of Antigonish, Guysboro and Halifax counties. He later visited Kentville in company with Mr. Schierbeck and Mr. A. H. Graham, examining the injury caused by the beech coccus. He returned to Ottawa on June 18.

On April 13 to 15, Mr. Arthur Gibson, Dominion Entomologist, presided over an important conference on Wild Life Conservation in Canada, at which a large number of Provincial and Federal representatives were present. During the three days of morning and afternoon sessions, many problems were reviewed. On May 7, Mr. Gibson visited Montreal to inspect the new fumigation and inspection building. He also attended the meetings of the Royal Society of Canada held in Ottawa May 19 to 21. On June 16, he went to Oakland, Calif. to the meeting of the Pacific Slope Branch of the American Association of Economic Entomologists. On June 28 he attended the annual meeting of the Northwest Association of Plant Pathologists, Entomologists and Horticulturists at Tacoma, Washington. En route to Ottawa he visited various Branch laboratories in Western Canada.

Mr. L. S. McLaine left Ottawa for Western Canada on May 16, to confer with various divisional officers and Customs authorities at several of the ports of entry. Mr. McLaine has arranged for European pine shoot moth inspections to be carried on at several points in the Prairie Provinces. In view of the discovery of this insect in Ontario in 1925, on imported pines, and indications that the pest has become established in certain sections of the province, scouting for the insect was started about the middle of May, pines imported in recent years especially being examined. Present reports indicate that the pest is quite generally distributed throughout southern Ontario, but local outbreaks are confined to small numbers of trees, which in most instances were secured from some of the larger importing nurseries quite recently. In British Columbia, Mr. McLaine had an opportunity of investigating the codling moth situation and outbreaks of the satin moth, European earwig and Lecanium scale. From June 9 to 12 he attended meetings of the Western Plant Quarantine Board at Olympia, Wash., with Mr. W. H. Lyne, Provincial Inspector.

Dr. L. O. Howard left Washington May 29 for an extended trip to the Pacific Coast. He expected to arrive at Seattle, Wash., on June 2; Portland, Ore., on the 5th, and at San Francisco, Calif., on the 8th. While in Seattle and Portland he planned to confer with those carrying on work against the European earwig and with Federal, state and station entomologists in Washington and Oregon. At Portland he conferred with Walter Carter, who has charge of the Bureau's investigations of the sugar-beet leafhopper. In California, stops were made at San Francisco, Sacramento, Stockton, Lake Tahoe, Los Angeles, Pasadena, Alhambra, Riverside, and the Escondido Valley for conferences with entomologists, quarantine inspectors, and others. He attended the scientific meetings in Oakland, the meeting of the Pacific Coast Entomological Society, and the meeting of the American Association of Economic Entomologists at Berkeley, delivering an address at the last on "Insects

and Human Progress," and also made an address before the Commonwealth Club of California. While in the Escondido Valley he investigated the silk culture that is being carried on there. Leaving San Francisco on the return trip about July 7, he expected to visit the Bureau's laboratories at Salt Lake City, Utah, Billings, Mont., and Monroe, Mich., and go to Ontario, Canada, for conferences with entomologists at Kingston, Toronto, and Ottawa, with special reference to the introduction and establishment of parasites of the European corn borer.

On April 28 the Branch of Forest Insects of the Bureau of Entomology was by invitation represented by a delegate to the National Committee on Wood Utilization, meeting in the Department of Commerce. This committee was established about a year ago by President Coolidge, and its secretary is Secretary Hoover of the U. S. Department of Commerce. The Bureau of Entomology is not only represented in the advisory research group, but also on two subcommittees, those of the construction industries group and the wood preservation group. Through the former group the Bureau will be represented on the executive committee. Some of the problems which will be referred to the Bureau of Entomology are a closer utilization of lower grades of lumber, including sound wormy stock; modification of city building regulations to prevent insect damage; and greater utilization of wood treated with chemical preservatives.

The following recent appointments in the Bureau of Entomology have been announced: C. O. Bare, Assistant Entomologist, celery leaf-tyer investigations, Plant City, Fla.; Oliver T. Deen and Perry K. Harrison, Junior Entomologists, sweet potato weevil investigations, Picayune, Miss.; C. B. Nickels, Assistant Entomologist, blueberry maggot investigations, Cherryfield, Me.; Dr. Paul M. Gilmer, Associate Entomologist in charge of codling moth investigations, Wichita, Kans.; Virgil N. Argo, temporary assistant, bee louse investigations, New Windsor, Md.; Dr. I. M. Hawley, Entomologist, alfalfa weevil investigations, Salt Lake City, Utah; also the following temporary assistants: V. E. Romney, Sugar beet leafhopper, Twin Falls, Idaho; E. K. Bynum, Australian tomato weevil, Gulfport, Miss.; M. W. Stone, wireworms, Walla Walla, Wash.; M. P. Jones, Mexican bean beetle, Athens, Ohio, and Dean Christenson, Howard C. French, Irven K. Revell and T. J. Blisard in cereal and forage crop investigations but whose assignments were not announced: A. D. Daughton and J. A. Beal, Southern pine beetle, Asheville, N. C., Ralph Miller, Western pine beetle, Klamath Lake region; L. Worr and G. S. Horton, forest insects, Minn., Leon Rintel and R. C. Hall, forest insects, New England States.

In the February number of the *Queensland Agricultural Journal* announcement is made of the appointment of Mr. Robert Veitch, B.Sc. (Agr.), B.Sc. (For.), F.E.S., as chief entomologist of the Queensland Department of Agriculture and Stock. The account is accompanied by a full-page reproduction of a photograph of Mr. Veitch. The following information is given: "Mr. Veitch was born in Edinburgh, Scotland, and educated at the Royal High School there and afterwards at the Edinburgh University. Later he went to the Imperial College of Science, London, subsequently taking a postgraduate course in science in Germany. He was appointed demonstrator in botany at his old Alma Mater in Edinburgh, and also conducted a course in Zoology at the Veterinary College in that city. Then followed an appointment as assistant entomologist in the Imperial Bureau of Entomology at the British Museum. He then entered the service of the Colonial Sugar Refining Company, and was engaged for eleven years in field scientific work as entomologist in Fiji, New South Wales,

and Queensland. He was also associated with pathological control problems. In the course of his connection with the Colonial Sugar Refinery, Mr. Veitch visited and worked in some of the principal experiment stations in the United States and Hawaii. Mr. Veitch is the author of a number of scientific publications, and is a valued contributor to numerous scientific journals."

Apicultural Notes

Extracted honey may now be stored in United States bonded warehouses with all the benefits of the United States Warehouse Act.

Miss Winifred S. Hull has been given a temporary appointment as Assistant Scientific Aid at the Bee Culture Laboratory, of the Bureau of Entomology. She is assisting Doctor Sturtevant in his work on bee diseases.

Mr. R. B. Willson, Extension Specialist in Apiculture of New York State, has accepted a position as Manager of the Honey Sales Department of the Herschel Jones Marketing Service, Inc., New York City.

Mr. E. I. Root, editor of *Gleanings in Bee Culture*, lectured on "Beekeeping" in the Redpath Chautauqua at various points in Tennessee from May 29 to June 21. These lectures were taken advantage of by the beekeepers in different parts of the State.

Mr. Virgil N. Argo on July 1st resigned his temporary appointment as Field Assistant of the Bee Culture Laboratory of the Bureau of Entomology. He was granted this appointment originally for the purpose of conducting investigations on the bee louse, *Braula coeca*, at New Windsor, Maryland.

Mr. W. L. Walling, State Apiarist of Tennessee, is active with his bee disease inspection work in all parts of the State. A few cases of American foul brood have been found, but are being cleaned up by the area clean-up method and will be under supervision throughout the year, also next year. Mr. Walling reports that the honey yield in Tennessee is exceptionally good and that the quality is high grade.

The temporary appointment of Miss S. Hilda Black as Junior Biologist of the Bee Culture Laboratory of the Bureau of Entomology has been extended until August 15 to enable her to continue the preliminary work on the nutritional value of honey begun with the cooperation of the Bureau of Home Economics of the Department of Agriculture.

United States Department of Agriculture Bulletin No. 284 by Dr. A. P. Sturtevant, on "The Sterilization of American Foulbrood Combs," has recently appeared. Another United States Department of Agriculture bulletin, Department Bulletin No. 1364, "Effects on Honeybees of Spraying Fruit Trees with Arsenicals," by Dr. N. E. McIndoo and Mr. G. S. Demuth, has also recently appeared.

The New York State Beekeepers' Association held a meeting at Colden, N. Y., on August 6; the Connecticut State Beekeepers' Association held a meeting at Storrs on August 3–4; and the Massachusetts State Beekeepers' Association held its summer meeting at Amherst on July 29. Meetings are also planned in New Hampshire and Vermont for the middle of August.

The discovery, in Quebec, of a mite not distinguishable from *Acarapis woodi* except in the fact that it is not harmful to honeybees has been reported by Doctor

Morgenthaler, of Switzerland, in "L'Abeille" and the "Schweizerische Bienen-Zeitung." These same harmless external mites have also been reported in Switzerland and Germany. The true *Acarapis woodi* has recently been reported from Russia.

Prof. L. M. Bertholf, of Western Maryland College, Westminster, Maryland, and Mr. Carlton E. Burnside, of the University of Michigan, have accepted temporary appointments as Junior Biologists of the Bee Culture Laboratory, of the Bureau of Entomology. Professor Bertholf is continuing his investigations on the light responses of the honeybee, while Mr. Burnside is continuing work on the fungous diseases of the honeybee.

Dr. E. F. Phillips of Cornell University and Mrs. Phillips sailed for Europe June 2. While abroad Doctor Phillips will preside at the Annual General Conference of the International Apis Club to be held in London August 5 to 7, and will deliver the presidential address on "The New Beekeeping." Various beekeepers' organizations in Switzerland, France, England and Scotland have arranged special meetings or excursions during the time of the visits to those countries. Doctor and Mrs. Phillips will return to Ithaca early in September.

Mr. D. M. T. Morland, Assistant in Charge of Beekeeping of the Rothamsted Station, England, again visited the Bee Culture Laboratory of the Bureau of Entomology during the first week of June on the completion of his tour to various apicultural investigational centers in the United States. He left Washington, D. C., for Canada, where he expected to visit the Beekeeping Department of the Ontario Agricultural College; the Dominion Apicultural Station under Mr. Gooderham; and Mr. C. Vaillancourt, in Charge of Beekeeping for the Province of Quebec.

A Chautauqua, as a memorial to the Dadant family, will be held by the Wisconsin State Beekeepers' Association on Aug. 17–20, at Plattville, Wisconsin. August 17 will be Wisconsin Day with Mr. N. E. France as chairman; August 18 will be Minnesota Day with Professor Jager as chairman; August 19 will be Illinois Day; and August 20 will be Iowa Day with Professor Paddock, as chairman. On Illinois Day the entire program will be in honor of the Dadant family. The programs on the other days will be devoted to questions of beekeeping practice.

Recent visitors at the Bee Culture Laboratory, of the Bureau of Entomology, included: Mr. C. J. Carroll, Chief Engineer of the Szechuen Hankow Railway, Hankow, China; Mr. George H. Rea, Extension Apiarist of Pennsylvania; Prof. Z. P. Metcalf, of North Carolina State College, Raleigh; and Dr. S. Soudek, of Bruno, Czechoslovakia. Since the first of the year Doctor Soudek has been studying apiculture with Doctor Phillips at Cornell University. During the summer he expects to make a tour to visit various apicultural stations and leading centers in the United States.

The Ohio Beekeepers' Association plans a Field Day at Medina, Ohio, the home of the A. I. Root Company, to be held September 21 to 23. The afternoon of the first day will be devoted to a memorial meeting to Mr. A. I. Root, founder of the company which bears his name, and the afternoon of the second day will be given over to a memorial to Rev. L. L. Langstroth, inventor of the modern hive. Prominent speakers from all parts of the country have accepted invitations to speak at the various sessions. Announcements of the detailed program will appear in the various bee journals or may be obtained from the Secretary of the Ohio Association, Miss Florence Naile, 118 West Northwood Avenue, Columbus, Ohio. The beekeepers of

several states have already arranged to go to these meetings together by automobile and it is anticipated that this will be one of the largest meetings of beekeepers ever held in the United States.

Notes on Medical Entomology

A control campaign against mosquitoes is being conducted at Ottawa by civic officials under the direction of the Dominion Entomologist. Mr. C. R. Twinn is acting in an advisory capacity in the field.

Mr. F. C. Bishopp of the Dallas, Texas laboratory of the Bureau of Entomology, was in Washington several days about the middle of April and presented a paper on cattle grubs before a meeting of representatives of various associations connected with the production of hides, skins, and leather, and representatives of the Departments of Agriculture and Commerce.

Dr. W. V. King, entomologist stationed at Mound, La., recently consulted with officers of the Marine Corps at Quantico, Va., at their request, concerning the advisability of attempting the control of mosquitoes at Quantico by applying arsenical dust to breeding places by means of airplanes.

During the meeting of the American Medical Association held in Dallas, Texas, April 19 to 23, Mr. R. J. Posson gave a paper before the American Association of Certified Milk Producers on the cooperative fly control project, which the Bureau of Entomology and the Bureau of Dairying has under way at the Beltsville Farm of the Bureau of Dairying. Much interest was manifested in the paper, as indicated by the discussion.

A demonstration of the disease of man known as Creeping Eruption was made by the Bureau of Entomology during the recent meeting of the American Medical Association in Dallas, Texas. Mr. W. E. Dove, who was in charge, presented data relative to the recent research work on this subject which he has been doing. The matter was presented to the physicians with the aid of numerous bromide enlargements showing various types of the disease, serial sections of the causative nematode, and charts depicting the distribution of the disease in the United States.

Pacific Slope Notes

Mr. Anthony Spuler, Assistant Entomologist, Washington Experiment Station, is stationed at Wenatchee, Wash., during the summer, working on certain phases of codling moth control.

Recent visitors at the department of zoology, Washington State College at Pullman, included M. C. Lane and Kenneth E. Gibson of the federal laboratory at Toppenish, and also L. P. Rockwood, of the Forest Grove, Ore. laboratory.

The recent death of Mr. Richard H. Stretch of Seattle, Wash., who formerly presented to the University of California a very complete collection of Bombycine moths, has removed one of the few remaining landmarks of Western entomology.

Mr. Walter Carter, Associate Entomologist in charge of the Twin Falls, Idaho, laboratory of the Bureau of Entomology, visited Riverside and Berkeley, Calif.

early in May to confer with Doctors Carsner and Severin regarding the investigations of the sugar-beet leafhopper under way in that State.

Mr. George I. Reeves, in charge of the Salt Lake City laboratory of the Bureau of Entomology, spent a considerable portion of the month of May on the survey of alfalfa weevil distribution, in the course of which he spent a brief time at the Sacramento, Calif., laboratory.

Mr. L. P. Rockwood, Associate Entomologist in charge of the Forest Grove, Ore., laboratory of the Bureau of Entomology, made a trip in May into eastern Oregon and Washington to aid in the alfalfa weevil survey in that region. He also investigated a grasshopper outbreak on the Colville Indian Agency at Nespelem, Wash., and made a brief visit to the Sacramento, Calif., laboratory.

Dr. L. O. Howard spent two days early in June in Seattle, Wash., in conference with state and federal officials regarding the outbreak of *Lecanium coryli* in western Washington. This scale insect, which has a wide variety of food plants, apparently was imported from Europe into British Columbia some twenty years ago, and has worked its way down as far as Seattle on the west coast.

The May number of the California *Citrograph* announces that the third session in subtropical horticulture will be held at the Citrus Experiment Station, Riverside, from June 26 to August 7. The purpose of the summer sessions is to furnish students and teachers of agriculture an opportunity to study subtropical horticulture in a region where the growing of tropical fruits is an industry of commercial importance. The courses will be given by the division of subtropical horticulture of the College of Agriculture, with the cooperation of the divisions of entomology and plant pathology of the Citrus Experiment Station. The faculty includes H. J. Quayle, professor of entomology; H. S. Smith, associate professor of entomology, and J. C. Chamberlain, assistant in entomology.

Mr. A. O. Larson of the Bureau of Entomology spent the first week of May in Stanislaus and Merced Counties, Calif., conferring with bean-weevil committees and holding Farm Bureau meetings at Hughson, Denair, Mitchell, and Tegner. About 200 growers attended the meeting at Hughson. Studies of the samples taken from last year's crops, made by Larson and Fisher and supplemented by the warehouse reports of this section, have aroused the growers to a realization that if they suffer loss it is largely their own fault. On May 14 and 15 Mr. Larson made an inspection of the bean warehouses in Orange and San Diego counties, and was pleased to find that although the quantity of beans held in storage was unusually large, they were remarkably free from weevils.

The California *Citrograph* for May announces the resignation of Professor George P. Gray of the California State Department of Agriculture, to become chief of the research department of the American Cyanamid Company, of which the Owl Fumigating Corporation of Azusa is a subsidiary. It is stated that Professor Gray as chief of the division of chemistry of the State Department of Agriculture devoted a part of his time to improving the processes of application of cyanide to citrus trees, and that it is this work that he will carry on for the American Cyanamid Company, with headquarters at Los Angeles. From 1916 to 1920 Professor Gray was assistant professor of entomology at the University of California, and from 1911 to 1920 he was chemist at the insecticide laboratory of the California Experiment Station.

Horticultural Inspection Notes

The strawberry root weevil, *Brachyrhinus rugifrons*, was found this summer for the first time in a strawberry planting in Colorado.

Mr. H. L. Sanford of the Federal Horticultural Board recently made a trip to Florida to examine some of the plantings of Narcissus bulbs in that state.

The exhibit prepared by the Federal Horticultural Board for the Sesquicentennial Exposition at Philadelphia has been installed by Mr. L. M. Scott.

Mr. Raymond O. Collyer has been appointed to the position of plant quarantine inspector with the Federal Horticultural Board and assigned to work at Douglas, Ariz.

Mr. O. D. Deputy, chief inspector for the Federal Horticultural Board in charge of the work on the Mexican border, was called to Washington recently for a conference.

The Mediterranean fruit fly was recently found by California state inspectors in tomatoes in the locker of an oil tanker from New Zealand via Honolulu, arriving in port at Los Angeles. The vegetables were confiscated and burned.

In Tennessee the inspections of the nurseries, greenhouses, strawberry plant fields, etc. are in progress. Assisting G. M. Bentley, State Entomologist, are H. L. Fackler, L. E. Barnes, D. E. Drinnon, J. C. Moser, J. B. Bailey, C. M. Wheeler and W. C. Wadsworth.

Mr. M. C. Rich, formerly employed as an inspector by the California State Department of Agriculture, has accepted an appointment with the Federal Horticultural Board and will do the necessary inspection at Palm City, Calif., across the line from Tia Juana, Mexico.

Miss Grace Sandhouse, who has been employed by the Federal Horticultural Board in Washington, was recently transferred to the Bureau of Entomology of the Department of Agriculture, and Miss Lussetie Blevins of the University of Illinois has been appointed to take her place.

Mr. George G. Becker, formerly chief inspector for the Arkansas State Plant Board, has accepted a position with the Federal Horticultural Board and has been placed in charge of the pink Bollworm work formerly carried on by the late Dr. W. D. Hunter. Mr. Becker will be stationed at Houston, Texas.

In reference to the road inspection carried on at various stations in the state of Arizona, a summary of the number of cars inspected and the amount of contraband material intercepted during the month of May, shows 10,678 cars examined and 914 out of this number, or about 9.1%, carried contraband material.

Two new quaranties have recently been issued by the Federal Horticultural Board, the Thurberia Weevil Quarantine No. 61 and the Narcissus Bulb Quarantine No. 62. Several existing quarantines have been revised, notably the European Corn Borer Quarantine No. 41, the Brown-Tail and Gypsy Moth Quarantine No. 45 and the Japanese Beetle Quarantine No. 48.

A conference was recently held in Washington to discuss the Thurberia weevil situation. Among those present at the meeting were Dr. Oscar C. Bartlett of Arizona, Messrs. B. R. Coad and T. P. Cassidy of the Bureau of Entomology, Mr. R. E. McDonald of Texas, Dr. J. H. Montgomery of Florida and Mr. F. S. Puckett of the Federal Horticultural Board stationed at Houston, Texas.

National Plant Board

The National Plant Board held its first meeting in Washington on June 25th at the Raleigh Hotel, to complete its organization. This Board is composed of two delegates from each of the four Regional Boards.

The officials chosen for the ensuing year are: Chairman, Lee A. Strong, Assistant Director of Agriculture, Sacramento, California; Vice Chairman, Wilmon Newell, Plant Commissioner, Gainesville, Florida; Secretary-Treasurer, W. A. McCubbin, Plant Pathologist, Harrisburg, Pa.

The time of the first session was largely occupied with organization matters but there also came up for discussion the recent amendment to the Plant Quarantine Act, various inspection practices in the different states, and the question of the desirability of discontinuing license fees and bonds in nursery inspection.

On Saturday morning, June 26th, the National Plant Board had a conference with the Federal Horticultural Board on problems arising out of the proposed domestic quarantine on Narcissus bulbs and on ways and means of obtaining more adequate protection against pests and diseases of tropical origin.

It is the hope of the members that this Board in its future activities will be of material help in smoothing out commercial inequalities and differences which now exist in the inspection and regulatory work in the various states, and thus enable our agricultural and horticultural industries to run on a more even keel than has heretofore been possible.

The organization and object of this national body will be more clearly understood from the following extracts from the constitution adopted at this meeting.

PURPOSE:—The functions of the National Plant Board shall be as follows:

(1) To represent the regional boards and to carry out instructions issued by the regional boards.

(2) To bring about through advisory action greater uniformity and greater efficiency in the promulgation and enforcement of plant quarantines in the various States; to act through the regional boards in an advisory capacity in the formulation of inspection policies and inspection practices in the individual States; to act as a clearing house of information on these subjects; to provide for discussion of principles, policies and methods and to make recommendations to the regional boards for the promotion of efficiency, harmony and uniformity in and among the States in the field of regulatory work.

(3) To maintain contacts with the Federal Horticultural Board and to confer with the Federal Horticultural Board on matters of quarantine policies which affect the United States at large and the individual States or groups of States. Action initiated by the National Plant Board shall not be interpreted as binding regional boards or individual States.

OFFICERS:—The officers of the Board shall consist of a chairman, a vice-chairman, and a secretary-treasurer, elected for a term of one year or until their successors are elected and qualified. . . . The chairman is authorized to appoint such committees at any time as seem necessary to the proper carrying out of the policies of the organization. The Board shall meet on the call of the chairman or on request of four members. The Board may transact business by letter ballot.

At the June 25 meeting a full representation of all regional boards was present, as follows: *Western:* M. L. Dean, director, Bureau of Plant Industry, Boise, Idaho, and Lee A. Strong, assistant director of Agriculture, Sacramento, Cal.; *Eastern:*

W. C. O'Kane, State entomologist, Durham, N. H. and W. A. McCubbin, plant pathologist, Dept. of Agriculture, Harrisburg, Pa.; *Central:* Frank N. Wallace, State entomologist, Indianapolis, Ind. and S. B. Fracker, State entomologist, Madison, Wis.; *Southern:* Wilmon Newell, plant commissioner, Gainesville, Fla. and George G. Becker, State Plant Board, Little Rock, Ark.

Summer Meeting of Northeastern Entomologists

The summer field meeting of the entomologists of the Northeastern States was held July 21 and 22. Some of the men gathered at the Hotel Woodstock, New York City, on the evening of July 30, and a conference was held on the Asiatic beetle situation, at which representatives from the States of Connecticut, New York, New Jersey, and the Bureau of Entomology were present. An infestation of this pest has recently been discovered at Jericho, Long Island, N. Y., and later it was found at Mt. Vernon, New Rochelle and White Plains, Westchester Co., N. Y.

On the following morning the Boyce Thomson Institute for Plant Research, at Yonkers, N. Y., was visited and the equipment inspected, and a light luncheon was served. Then the party in automobiles crossed into New Jersey and examined some of the tide gates, dikes, and electric centrifugal pumps used in mosquito work. A late luncheon was procured in Newark, and the party proceeded to New Brunswick and a short stop was made at the insectary, where the Oriental peach moth investigations are in progress. Point Pleasant was reached in the evening, where the group spent the night. The following morning the party traveled through Lakehurst and stopped to view the dirigible airship, *Los Angeles*, and the hangar where it is kept, thence to Whitesbog, and inspected the blueberry and cranberry plantations there, where the New Jersey Station has an insectary devoted to cranberry troubles. A spraying demonstration was staged for the benefit of the visitors. All hands then proceeded to Brown's Mill for luncheon, after which two stops were made on the New Jersey plains—one to see bees resistant to European foul brood, and the other the bee-queen mating station. Then the party went through ditched and unditched salt marsh areas to Atlantic City for dinner and lodging. Some of the members had to leave before reaching this point but a goodly number visited the Japanese Beetle Laboratory at Riverton on July 23. The committee on nominations and place of next meeting reported after luncheon at Brown's Mills, that the meeting next year be held in Virginia, Maryland, and Pennsylvania with headquarters at Winchester, Va., and the following officers were elected: Chairman, W. J. Schoene, Blacksburg, Va.; Secretary, T. L. Guyton, Harrisburg, Pa. The following members attended: Dr. E. P. Felt, H. L. McIntyre, Saul Phillips, Albany, N. Y.; Dr. Hugh Glasgow, R. Cecil, Geneva, N. Y.; J. L. Horsfall, New York City; Dr. Albert Hartzell, Miss Irene Dobroscky, Yonkers, N. Y.; Dr. T. L. Guyton, J. R. Stear, F. M. Trimble, J. N. Knull, H. B. Kirt, C. A. Thomas, O. R. Hansen, Harrisburg, Pa.; J. G. Sanders, P. T. Barnes, Phila., Pa.; Dr. W. E. Britton, Dr. Philip Garman, R. C. Botsford, New Haven, Conn.; John T. Ashworth, Danielson, Conn.; Dr. Robert D. Glasgow, Urbana, Ill.; W. J. Shoene, Blacksburg, Va.; H. L. Dozier, Dover, Del.; A. F. Burgess, H. L. Blaisdell, Thos. H. Jones, S. M. Dohanian, Melrose Highlands, Mass.; Loren B. Smith, C. W. Stockwell, J. L. King, Dr. Alvah Peterson, Riverton, N. J.; Dr. T. J. Headlee, C. S. Beckwith, L. A. Stearns, C. C. Hamilton, W. Rudolfs, F. C. Nelson, Ray Hutson, Frank Miller, Richard Huizing, Raymond Del Tufo, C. E. Cobb, New Brunswick, N. J.; John Peterson, Alfred J. Tipping, Englewood, N. J.; Russell W. Gies, Elizabeth, N. J., R. B. Lott, Trenton, N. J.